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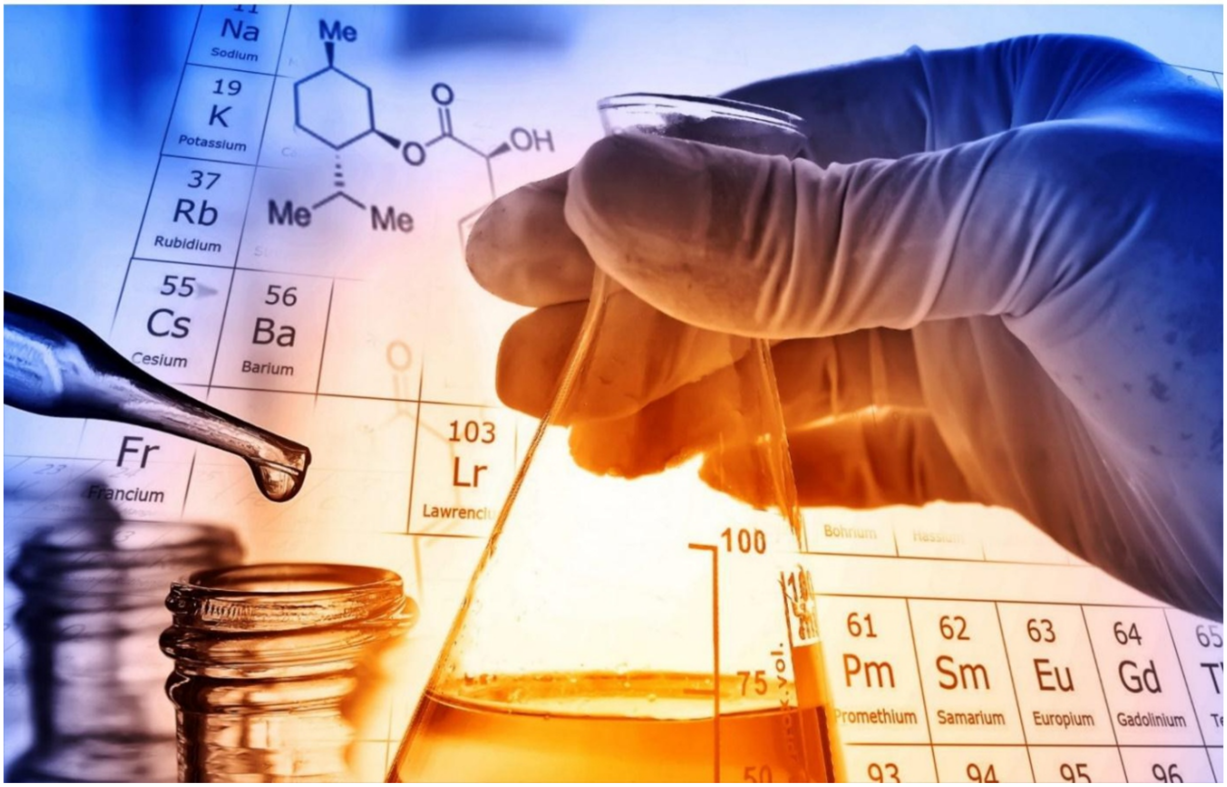

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MATHEMATICAL COMPETENCIES AS DETERMINANTS OF SECONDARY SCHOOL ACADEMIC ACHIEVEMENT IN PHYSICS FOR SUSTAINABLE EDUCATION

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Abstract

The poor secondary school students' academic achievement in Physics as shown in the literature over the past decades has been attributed to poor acquisition of mathematical competencies that can enable them to do well in practical Physics. The need to examine mathematical competencies as determinants of Physics achievement becomes necessary for sustainable education. The study which adopted an ex-post facto research design was carried out in Nsukka education zone of Enugu state during the 2021/2022 academic session. The sample size for the study was 388 senior secondary school II Physics students in 6 randomly sampled single-sex secondary schools. Trained research assistants used interview results to fill the mathematical competency in practical Physics questionnaire (MCPPQ) for each student. Grades spreadsheet was used to collect students' senior secondary certificate examination result in Physics. Cronbach's alpha, which yielded a value of .85 was used to measure the internal consistency reliability of MCPPQ. Beta-weight was used to answer all the research questions while Chi-square statistic was used to test the hypotheses at .05 level of significance and 425 degrees of freedom. The result of the study as perceived by the students indicated that basic practical Physics mathematical operations, graphing skills, generation of readings from equations derived from experimental setup and deductions from the graph in decreasing magnitude positively influenced Physics achievement in external examination. Male and female students' models were similar in terms of path coefficients in the model. Hence, it was recommended that Physics teachers should improve upon students' mathematical competencies in practical Physics to boost their Physics achievement.

Keywords: Mathematics, Physics, gender, achievement and sustainable development.

Introduction

The global community has recognized the critical role of education in achieving sustainable development goals (SDGs). Education serves as a catalyst for economic and social transformations by equipping individuals with knowledge, skills and values necessary for personal growth and active participation in the development process. SDGs encompass a wide range of interconnected objectives, such as poverty eradication, environmental, social and educational sustainability. Achieving the educational sub-goal requires a holistic approach that addresses various dimensions of education. Educational dimension can cut across subject areas and creating room for subject interaction. Such interaction nature has necessitated one subject area to be dependent on one another. In order words, one subject can be a determinant of success in another subject. For example, knowledge gained in Mathematics can be a determinant of meaningful learning in Physics.

In the context of secondary school education in Nigeria, one subject that has faced persistent poor achievement challenge is Physics. External examinations in Nigeria have consistently revealed poor achievement rates in Physics among secondary school students. This poor achievement raises concerns about the quality of Physics education and its implications for the attainment of sustainable development goals in Nigeria. Among the various factors affecting students' achievement in Physics, poor mathematical competencies emerge as a crucial factor. The West African examinations council, WAEC (2016, 2017, 2018 & 2019) in all its series examinations partly attributed poor achievement of students in Physics to poor application of mathematical concepts. The summary of the poor mathematical concepts of the Physics students in practical Physics as listed by WAEC included: (i) inability to read measurement from instruments to the required accuracy.(ii) inability to tabulate data correctly. (iii) inconsistency in decimal places. (iv) inability to plot graphs correctly (iv) poor determination of slopes and (v) over approximation of evaluated values. (vi) Inability to plot graph when values are negative. (vii) inability to express figures in standard form and (viii) inability to convert raw values using the given scale factor.

Mathematical competency is operationally defined in this study as the comprehension and application of mathematical concepts, principles and problem-solving strategies necessary for understanding and excelling in the use of the principles of Physics to solve educational problems in the classroom. In this study, it encompasses generation of readings from equations, application of basic mathematical operations indexed in practical Physics, graphing skills and making deductions from the graph. Theoretical generation of readings in practical Physics for secondary school students is the art of using equations derived from the experimental setup to obtain the values of variables that are set to be determined in an actual experimentation. The basic mathematical operations in practical Physics involve addition, subtraction, square, square-root, cube and cube-root. Others are inverse operations and logarithmic transformations and approximations: significant figures and decimal places. The graphing competency refers to manual plotting of the graph of the ordinate against abscissa, observing zero-zero origin with good scales on both axes. Deduction from graph is operationally defined as drawing the best line of fit, slope and intercept measurements. It also involves correct interpretation of slope, ordinate and abscissa intercept values for measurement of physical constants.

Students' gender has also been reported in literature to influence achievement in Physics. Gender refers to the social and cultural roles, expectations, and identities associated with being male or female within a given society. It encompasses the range of characteristics, behaviors, and expressions that are culturally attributed to masculinity and femininity (Butler, 1990). Understanding gender as a social construct highlights the importance of examining its influence on various aspects of individuals' lives, including academic pursuits such as physics achievement. Gender equality in education is a fundamental aspect of sustainable development. It ensures that girls and women have equal access to education, compared to their opposite gender. Girls and women education do not only encourage their individual well-beings but also contribute to the overall development of the society at large. Educated women are more likely to participate in decision-making processes, promote health and well-being within their families and contribute to economic growth more than their uneducated counterparts. Moreover, despite significant advancements, gender disparities persist in many educational systems worldwide, hindering the attainment of sustainable development goals. The term "gender differentials" refers to the variations observed between genders in a particular area, such as physics achievement. It acknowledges the potential differences in achievement that exist between males and females within an academic circle. Perspectives on gender differentials in Physics achievement appear to lack a specific direction. Physics Education researchers like Anamezie and Nnadi (2019) indicated in their study that there was no gender differential in achievement of Physics students when the instructional stimulus was drill and practice mode of computer aided instruction, other studies other used varied instructional stimuli or opinions reported the existence of gender differentials (Ugwu, 2011; Wang & Degol , 2017; Stoet & Geary,2 018;Yakubu, 2021).

Achievement in Physics as a school subject hugely relies on mathematical principles and concepts for problem-solving and understanding complex phenomena. Mathematical knowledge provides the foundation upon which students build their understanding of Physics, enabling them to apply theoretical principles to practical situations effectively. Dirac (1939), a known physicist while explaining the relevance of mathematical knowledge to Physics understanding noted that the physicist had two methods of making scientific inquiry: (i) the method of experimentation and observation and (ii) the method of mathematical reasoning. According to Dirac, experimentation is just for collection of data and the latter enables one to infer results about experiments that have not been [fully] performed. The method of simulating results that have not been fully performed falls in line with the use of mathematical models or equations to predetermine the supposed experimental values, keeping some experimental attenuation constant. Ataide and Greca (2013) observed that Physics students should have a deep understanding of Mathematical skills and utilize them when it is necessary in Physics. Juan (2001) also supported the relevance of Mathematics to Physics understanding, by indicating that Mathematics had a fundamental role to pay in modern science, since every scientific theory was rooted on a mathematical model or law. Therefore, inadequate possession of sound mathematical skills can impede students' ability to achieve in Physics examinations.

Equations derived from mathematical principles allow students to describe and predict the behavior of physical systems. In mechanics, for example, secondary school students can be taught how to derive a mathematical equation that connects all the variables in an experimental setup using algebraic symbols. For illustration, in an experiment to measure the mass of a uniform meterstick (M) in the laboratory using a knife-edge and set of masses, m. The centre of gravity, CG of the meterstick is measured in a real experiment when no mass hangs on it. By hanging m, at a constant length of 5cm from the zero-end of the meterstick, and balancing it horizontally, perpendicular distance a(cm) between m and knife-edge and b (cm) between the knife-edge and CG, an algebraic equation can be obtained for measurement of the values of ‘a’, ’b’ and ‘M’ using the principle of moment of force. From algebra, ma=Mb. 50= a+b+5. M = (g). Hence, for different values of ‘m’ and ‘a’, M can be estimated and their average values obtained to represent M, experimentally. Theoretically, the values of ‘a’ and ‘b’ which the experiment seeks to measure can be obtained without measurement. Since ‘a’= using algebra, the values of ‘a ’ for each value of ‘m’ can be calculated, given M in the last equation. The value of ‘b’ is calculable, given ‘a’. What the researcher is arguing in the above example is that a little experimental measurement of the constant term like M in a mathematical equation or an experimental setup is needed to determine the values of varying parameters which experimentation seeks to achieve. This is achieved when the values of other connected variables in the experiment like ‘m’ are known, without fully performing the experiment. Once M is determined by direct measurement using lever or electronic balance, the values of m like 100g, 200g are substituted into the algebraic equation one at a time, the values of the variables: ‘a’ and ‘b’ which the experiment seeks to measure can be obtained through calculation. This procedure has the propensity to awaken the curiosity of the students in problem solving. In addition, it acts as a benchmark for assessing the precision of experimental results.

Algebra is the theoretical framework of this study. It plays a pivotal role in bridging the gap between mathematical knowledge and Physics achievement. Algebra is a branch of Mathematics that uses symbols to represent physical phenomena. Mordern algebra according to Kvasz (2006) was propounded by Cardano (1501-1576), who used a set of rules to solve equation of the third degree. It also encompasses the rules for manipulating symbols to solve equations and study physical phenomena. The use of algebraic equation to solve problems in practical Physics is applied in the mathematical aspects of practical Physics emphasized in this study.

To explore the application of mathematical knowledge in understanding Practical Physics, it is important to review existing literature on the topic. Several studies have demonstrated the positive relationship between mathematical knowledge and Physics achievement in secondary schools (Thompson & Steinberg, 2014; Smith, 2015; Ramirez &Ramos, 2016; Kapucu, et al., 2016; Johnson et al., 2017; Wu et al., 2017; Chen & Klahr, 2018; Brown & Lee, 2019; Hu et al., 2019; Li et al., 2021; Chen, et al., 2021). These studies highlight the significance of mathematical skills in conceptualizing and solving Physics problems, emphasizing the need for integrated approaches that promote the development of both mathematical and Physics competencies. However, the study conducted by Winter and Airey (2022) negated the earlier findings. The authors indicated that success in Mathematics can often mask a lack of conceptual understanding among undergraduates. Since there is no uniformity in the results of earlier conducted studies, there is the need to study the relationship between mathematical knowledge and Physics achievement using structural equation model. The essence of structural equation model analysis, according to Schumacker and Lomax (2010) is to measure the extent to which the theoretical model is supported by sample data. The structural model allows a holistic analysis of the relationships between unobservable phenomena like graphing skill and observable phenomenon (Physics achievement) as they are enshrined in the structural model.

Statement of the Problem:

The Physics students' poor achievement in senior secondary school certificate examination (SSCE) as shown in the literature over the past decades has been adduced to poor mathematical skill. Mathematical skill including the use of algebraic expression is very common in Physics teaching and learning. The understanding of mathematical skill by the Physics students is an important tool for success in Physics, including practical Physics. The WAEC chief examiners have consistently reported that the Physics students had poor mathematical skills in practical Physics. It is against this backdrop that the present study is being carried out to measure the linear relationship between mathematical skills and achievement in SSCE Physics. Therefore, the educational problem of this study posed as a question is: how far does mathematical knowledge act as a cofactor of secondary school Physics students' achievement in senior secondary school certificate examination for sustainable development?

Purpose of the Study

The purpose of the study was to measure mathematical competencies as determinants of secondary school Physics achievement for sustainable development. The study specifically sought to develop a structural equation model for measurement of the:

1. Beta-weight of the path between 'generation of readings from equation derived from the experimental setup after direct measurements of some constants in the experiment' and achievement in Physics senior secondary school certificate examination in the combined model
2. Beta-weight of the path between 'application of basic mathematical operations in practical Physics' and achievement in Physics senior secondary school certificate examination in the combined model.
3. Beta-weight of the path between 'graphing skill' and achievement in Physics senior secondary school certificate examination in the combined model.
4. Beta-weight of the path between 'deductions from the graph' and achievement in Physics senior secondary school certificate examination in the combined model.
5. Existence or otherwise of a significant difference between beta-weights in the observed and expected structural equation model of male Physics students.

6. Existence or otherwise of a significant difference between beta-weights in the observed and expected structural equation model of female Physics students.
7. Existence or otherwise of a significant difference between male and female students' beta-weights in the combined structural equation model.

Research Questions

The following research questions guided the study:

1. What is the beta-weight of the path between 'generation of readings from equation derived from the experimental setup after direct measurements of some constants in the experiment' and achievement in Physics senior secondary school certificate examination in the combined model?
2. What is the beta-weight of the path between 'application of basic mathematical operations in practical Physics' and achievement in Physics senior secondary school certificate examination in the combined model?
3. What is the beta-weight of the path between 'graphing skill' and achievement in Physics senior secondary school certificate examination in the combined model?
4. What is the beta-weight of the path between 'deductions from the graph' and achievement in Physics senior secondary school certificate examination in the combined model?

Hypotheses

The following null hypotheses tested at .05 level of significance guided the study:

$H0_1$: There is no significant difference between beta-weights of the paths in the observed and expected structural equation model of male Physics students.

$H0_2$: There is no significant difference between beta-weights of the paths in the observed and expected structural equation model of female Physics students.

$H0_3$: There is no significant difference between male and female students' structural equation models' beta-weights in the combined model.

Method

Ex-post facto also known as causal comparative research design was employed in the study. The choice of the design was because there was no manipulation of the variables and data in the study. The study was carried out in Nsukka education zone of Enugu State, Nigeria during 2021/2022 academic session. The population for the study consists of 12,672 students in 31 public secondary schools in Nsukka education zone (Statistical unit, Post primary schools Management Board, Enugu state, 2022). The sample for the study was 388 consisting of 204 female and 184 male Physics students. Simple random sampling technique, precisely balloting with replacement was used to sample two schools each from the three Local Government Areas under the education zone: Igbo-Etiti, Nsukka and Uzo-Uwani. Balloting with replacement was also used to sample only one stream of senior secondary school three Science class in the six schools. There was unequal number of the students in the sampled schools. Using purposive sampling technique, three least populated schools were included. The remaining number was sampled using simple balloting with replacement. Purposive sampling technique was adopted to make sure that the least populated school had a chance of being included in the study. Interview was used as a primary source of data collection. Ten research assistants who were regular graduate Physics teachers were trained on how to collect data that were related to mathematical competencies in practical Physics. They were recruited as research assistants in the study because they showed evidence of having become WAEC examiners in Physics for at least two years. During the interview sessions which lasted for one month, students were scored 1 mark for correct display or answer to a question and 0 mark for non-possession of the needed mathematical competency. Mathematical competency in practical Physics questionnaire (MCPPQ) was used to collect data from the students by the research assistants during the interview. Students' scores ranging from 1-25%, 26-50%, 51-75% and 76-100% attracted 1, 2, 3 and 4 points respectively. Grades sheet was used to collect the students' year 2022 West African senior secondary certificate examinations (WASSCE) results in Physics, when they were released. MCPPQ was developed by the researcher. It had thirty-items with four-point rating scale ranging from 4(*Very High Extent)* to 1(*Very Low Extent).* MCPPQ had two sections: A and B. Section A sought information on demographic factors of the respondents while section B had four clusters: Application of basic mathematical operations in practical Physics for sustainable development, Generation of readings from equation derived from the experimental setup after direct measurements of some constants in the experiment for sustainable development, Graphing skills for sustainable development and Deductions from the graph for sustainable development. The original MCPPQ which had 54 items was both face and construct validated prior to its usage. The face validation targeted clarity, appropriateness and structure (positively and negatively worded) of the wordings of MCPPQ, whereas exploratory factor analysis (EFA) was used to measure the alignment of the factors of MCPPQ unto latent constructs. The preliminary result of the EFA showed the presence of 4 constructs with valid 30 items. The internal consistency reliability of MCPPQ was measured using Cronbach's alpha. Its value was .85. The students' SSCE results in Physics were collected using researcher-developed grades spreadsheet. The SSCE Physics grades were rated by West African Examinations Council, WAEC on nine-point inverse-stanine grades: A_1, B_2, B_3, C_4, C_5, C_6, D_7, D_8 and F_9. The researcher reversed the scoring of the collected grades to ensure that (i) higher grades attracted higher scores and (ii).equality of WAEC grades and MCPPQ rating scale was achieved as follows: 4(A_1-B_3), 3(C_4-C_6), 2(D_7-D_8) and 1(F_9). The structural equation model based on the four latent constructs of MCPPQ was developed with their respective indicators using analysis of moment structures computer programme version 20. The path between each of the four latent constructs of MCPPQ and SSCE Physics grade was sought in the model. The data submitted for analysis did not have any case of missing data. Maximum likelihood estimation technique was adopted in the structural equation model parameters' estimations. The reason was because it had higher precision and accuracy relative to many model parameter estimators. Beta-weights were used to answer the research questions while the null hypotheses were tested at .05 level of significance using Chi-square statistic. For the research questions, the interpretation of regression coefficients is as follows: 0.1-0.3(*low positive relationship),* 0.40-0.6 (*moderate positive relationship*) and 0.7-0.9 (*high positive relationship*) and vice versa. The decision rule for the hypothesis is that if the estimated probability, p value attached to the Chi-square value with its degree of freedom is less than the .05 level of significance set for the study, the null hypothesis is rejected. Similarly, if the estimated probability, p value is more than the .05 level of significance set for the study, the null hypothesis of no significant difference is accepted.

Results

Research Question 1:

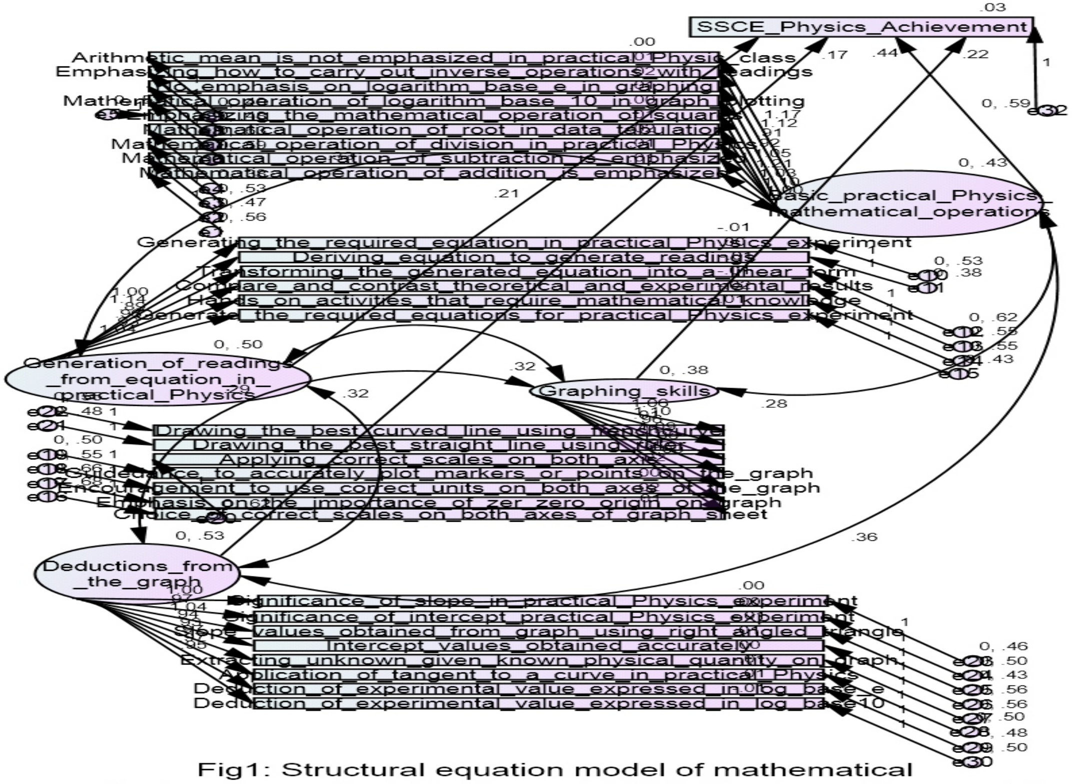
What is the beta-weight of the path between 'generation of readings from equation derived from the experimental setup after direct measurements of some constants in the experiment' and achievement in Physics senior secondary school certificate examination in the combined model?

Table 1 below shows that the beta-weight of the path between generation of readings from equations from practical Physics setup and SSCE Physics achievement in the direction shown by the arrow. The estimated beta-weight of the path is 0.12.

Table 1: The coefficient of linear regression between the path: Physics achievement and generation of readings from equations in practical Physics in the combined model.

Linear Regression path	Beta-weight
SSCE Physics Achievement and Generation of readings from equations in practical Physics	0.21

This is a low positive relationship between the variables being measured. Figure 1 shows the sample of the evaluated structural equation model for combined male and female subgroups.


SSCE_Physics_Achievement
.03
.17
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0, .59
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Emphasizing_how_to_carry_out_inverse_operations_with_readings
No_emphasis_on_logarithm_base_e_in_graphing
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Mathematical_operation_of_addition_is_emphasized
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Drawing_the_best_straight_line_using_ruler
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Guidance_to_accurately_plot_markers_or_points_on_the_graph
Encouragement_to_use_correct_units_on_both_axes_of_the_graph
Emphasis_on_the_importance_of_zero_origin_on_graph
Choice_of_correct_scales_on_both_axes_of_graph_sheet
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Deductions_from_the_graph
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.36
Significance_of_slope_in_practical_Physics_experiment
Significance_of_intercept_practical_Physics_experiment
Slope_values_obtained_from_graph_using_right_angled_triangle
Intercept_values_obtained_accurately
Extracting_unknown_given_known_physical_quantity_on_graph
Application_of_tangent_to_a_curve_in_practical_Physics
Deduction_of_experimental_value_expressed_in_log_base_e
Deduction_of_experimental_value_expressed_in_log_base10

Fig1: Structural equation model of mathematical applications in practical Physics and SSCE Physics achievement for combined subgroups

Research Question 2:

What is the beta-weight of the path between 'basic practical Physics mathematical operations' and achievement in Physics senior secondary school certificate examination in the combined model?

Table 2 below shows the beta-weight of the path between basic practical Physics mathematical operations and SSCE Physics achievement in the direction shown by the arrow. The estimated beta-weight of the path is 0.44.

Table 2: The coefficient of linear regression between the path: Physics achievement and basic practical Physics mathematical operations in the combined model.

Linear Regression path	Beta-weight
SSCE Physics Achievement and Basic practical Physics mathematical operations	0.44

The value of the path coefficient shows that a moderate positive relationship between SSCE Physics Achievement and basic practical Physics mathematical operations.

Research Question 3:

What is the beta-weight of the path between 'graphing skill' and achievement in Physics senior secondary school certificate examination in the combined model?

In Table 3 below, the beta-weight of the path between graphing skill in practical Physics and SSCE Physics achievement in the direction shown by the arrow has a that is value equal to 0.22.

Table 3: The coefficient of linear regression between the path: Physics achievement and graphing skill in practical Physics in the combined model.

Linear Regression path	Beta-weight
SSCE Physics Achievement and Graphing skill in practical Physics	0.22

The value of the path coefficient shows that a low positive relationship between SSCE Physics Achievement and graphing skill in secondary school practical Physics exists.

Research Question 4:

What is the beta-weight of the path between 'deductions from the graph' and achievement in Physics senior secondary school certificate examination in the combined model?

Table 4 below shows the path between deductions from the graph in practical Physics and SSCE Physics achievement in the direction shown by the arrow. The estimated beta-weight of the path is 0.17.

Table 4: The coefficient of linear regression between the path: Physics achievement and deductions from graph in practical Physics in the combined model.

Linear Regression path	Beta-weight
SSCE Physics Achievement and Deductions from graph in practical Physics	0.17

The value of the path coefficient shows that a low positive relationship between SSCE Physics Achievement and deductions from the graph in practical Physics exists.

Hypotheses:

$H0_1$: There is no significant difference between path coefficients in the observed and expected structural equation model of male Physics students (p .05).

Table 5 shows the result of the Chi-square test for male Physics students' model. The Chi-square has a value of 435.172. The degree of freedom in the model, associated to the Chi-square is 425. The significance attached to the stated Chi-square and degree of freedom values for the model has a value of .356.

Table 5: The Chi-square value for male Physics students' model.

Chi-square	df	Significance	Decision
435.172	425	.356	Accept null hypothesis

Since the significance value of .356 is more than .05 level of significance set for the study, the null hypothesis which posits that there is no significance difference between observed and expected path coefficients in the structural equation model is accepted. This means that both sets of data (theoretical and empirical) fit the path model based on the hypothesis of similar path coefficients. The Chi-square significance shows that the regression weights in the male students' model were valid enough to be accepted.

$H0_2$: There is no significant difference of path coefficients in the observed and expected structural equation model of female Physics students (p .05).

Table 6 shows the result of the Chi-square test for female Physics students' model. The Chi-square has a value of 477.982. The degree of freedom in the model, associated to the Chi-square is 425. The significance attached to the stated Chi-square and degree of freedom values for the model has a value of .068.

Table 6: The Chi-square value for female Physics students' model.

Chi-square	df	Significance	Decision
477.982	425	.068	Accept null hypothesis

Since the significance value of .068 is more than .05 level of significance set for the study, the null hypothesis which posits that there is no significance difference between observed and expected path coefficients in the structural equation model is accepted. This means that both sets of data (theoretical and empirical) fit the path model based on the hypothesis of similar path coefficients. The Chi-square significance shows that the regression weights in the female students' model were valid enough to be accepted.

$H0_3$: There is no significant difference between male and female students' structural equation models' path coefficients (p .05).

Table 7 shows the result of the Chi-square test for the combined male and female Physics students' model. The Chi-square has a value of 409.621. The degree of freedom in the model, associated to the Chi-square is 425. The significance attached to the stated Chi-square and degree of freedom values for the model has a value of .695.

Table 7: The Chi-square value for the combined Physics students' model.

Chi-square	df	Significance	Decision
409.621	425	.695	Accept null hypothesis

Since the significance value of .695 is more than .05 level of significance set for the study, the null hypothesis which posits that there is no significance difference between observed and expected path coefficients in the structural equation model is accepted. This means that both sets of data (theoretical and empirical) fit the path model based on the hypothesis of similar path coefficients. The Chi-square significance shows that the regression weights in the combined male and female students' model were valid enough to be accepted.

Discussion of the Findings

The findings of the study showed that a positive linear relationship exist between SSCE Physics achievement and generation of readings from equations in practical Physics. Basic practical Physics mathematical operations, graphing skills and deductions from the graph have positive linear relationship with SSCE Physics achievement. Basic practical Physics mathematical operation has the highest linear relationship with SSCE Physics achievement in terms of standard deviation units in the model. Graphing skill is followed by generation of readings from equations in terms of explaining the variance in SSCE Physics achievement. The least positive contributor in the explanation of the variance in SSCE Physics achievement in the model was deduction from the graph. The findings are in tandem with earlier studies (Thompson & Steinberg, 2014; Smith, 2015; Ramirez &Ramos, 2016; Kapucu, et al., 2016; Johnson et al., 2017; Wu et al., 2017; Chen & Klahr, 2018; Brown & Lee, 2019; Hu et al., 2019;; Li et al., 2021; Chen, et al., 2021) which stated that a positive linear relationship existed between mathematical knowledge and Physics achievement. However, the present finding is at variance with the finding of Winter and Airey (2022), who indicated that mathematical knowledge was not a factor in the prediction of Physics achievement. None of the studies reviewed utilized structural equation model (SEM) to test the linear relationships between the mathematical concepts applied to practical Physics and SSCE Physics achievement. SEM is a hybrid model for studying the relationships between latent and observed variables as a whole. The model provided a good fit to the data. It was also found out that the path coefficients were similar for male and female sub-samples. This means that the result of this study can be applied to both male and female sub-samples.

Conclusion and Recommendations

Mathematical knowledge is positively related to Physics achievement. It is recommended that Physics teachers should emphasize mathematical knowledge in practical Physics classes for attainment of sustainable development goals.

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KNOWLEDGE AND PRACTICE OF PERSONAL HYGIENE AMONG SECONDARY SCHOOL STUDENTS IN ENUGU STATE

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Abstract

In academic sector, they are high rate of infectious diseases like measles, diarrhea, coronavirus, monkey-pox, skin disease and genital infections, the occurrence of these infectious diseases came as a result of students' negligence in practicing of personal hygiene. Therefore, this study examined knowledge and practice of personal hygiene among secondary school students in Enugu State. Two specific purpose and research questions guided the study. Descriptive survey research design was adopted for the study. The population for the study consisted of 9900 secondary school students in Enugu State. 495 students made up the sample for this study. The researcher used simple random sampling technique. Specifically the reliability coefficients obtained from data generated with Statistical Package for Social Sciences (SPSS) using Kuder Richardson formula and Cronbach's alpha reliability for the internal consistency reliability, shows knowledge of personal hygiene (.85) and practice of personal hygiene (.79) respectively. A 22-items structured questionnaire tagged "Knowledge and Practice of Personal Hygiene Questionnaire (KPPHQ)" was used for data collection. The data collected were analyzed using frequency, percentage, mean and standard deviation. The questionnaire was rated on 4-point scale of very great extent (VGE), great extent (GE), low extent (LE) and very low extent (VLE). The decision rule was that any item that has 50% and above is regarded as knowledgeable (K) while items below 50% is regarded as not knowledgeable (NK). For the personal hygiene, any item mean from 2.50 above is regarded as high while items mean below 2.50 is regarded as low. The findings showed that, majority of students have adequate knowledge of personal hygiene with the grand percentage of (69.8%) and low practice of personal hygiene with the grand mean of (2.0). The study conclude that: students are very knowledgeable of personal hygiene, but putting their knowledge into physical practice are seen as the major problems that most students face, which usually contribute to the risk of infectious diseases such as covid-19, genital infections, dental health challenges and diarrhea. The study recommend that students' knowledge as it regards to personal hygiene practice should always be appraised by the classroom teacher, for the purpose of motivating those ones that have low knowledge of personal hygiene and the school management should provide all the prerequisite personal hygiene materials for the facilitation of its practice.

Keywords: Personal hygiene, practice, knowledge and students.

Introduction

Good health is one of the desires of human beings and one of the essential individual practices that contribute immensely to health promotion is personal hygiene practices. On the contrary, negligence on the practice of personal hygiene by students may adversely affect the students' health state which may as well lead to contraction of infectious diseases from one student to another and this may increase the rate of truancy in school. Nevertheless, the emergence of coronavirus, monkey-pox, measles and chicken-pox came as a result of poor knowledge and practice of personal hygiene by majority of students. According to Loughlin (2016), personal hygiene are measures taken at individual level to promote personal cleanliness so that transmission of diseases from source to susceptible hosts is prevented. Ahmadu (2013), defines personal hygiene as those personal care practiced by individual which may include keeping our body, our teeth, our hair, our clothes and our genital area clean in order to combat germs on the body that could lead to illness. The author adds that personal hygiene is a complex process which combines various practices aimed at achieving cleanliness through personal action, dedication and personal commitment towards keeping the body healthy.

The behavior aimed at achieving cleanliness and requires repeated personal action, dedication, commitment is known as personal hygiene practices. Hygiene practice refers to the habitual way of doing something consistently. Ali, Rahman and Siddiqui (2013), defines personal hygiene practices as the practice of maintaining cleanliness through regular health practice such as; washing hands with soap and water before meals and after defecating, brushing of teeth twice daily, regular taking of bath with soap and water, keeping nails short and regular exercise. This submissions highlights that personal hygiene practices does not only mean the health restricted to individual body, rather it may also constituted those health practice within our home environment. Similarly, Kumie, (2015), Lalani, (2015) and Lukacs (2016), defines personal hygiene practice as a practical approach towards regular hygiene practice which comes as a result of sufficient knowledge with regards to personal and environmental health. This shows that the regular compliance to these personal hygiene practices may lead to promotion of health, prevention of communicable diseases and improvement of individual physical beauty. No wonder, WHO (2023), opines that having knowledge of personal hygiene may lead to regular hygienic practices which will positively enhance the state of health individually and the society at large, while poor knowledge of personal hygiene practice is a risk factor that may lead to increase in spread of communicable diseases such as coronavirus, monkey pox, chicken pox and measles

Ali, Rahman and Siddiqui (2013) highlighted some of the major components of personal hygiene, which include body hygiene (skin care), oral hygiene (oral care), hand washing (hand care), face hygiene, fingernail and toe nail hygiene (nail care), ear hygiene, hair hygiene, foot hygiene, arm pit and bottom hygiene, clothes hygiene and menstrual hygiene. According to him, several studies show that personal hygiene practices is not limited to its component rather it also include seeing a doctor, seeing a dentist, regularly washing (bathing or showering) of the body, regular hand washing, brushing and flossing of teeth, basic manicure and pedicure, feminine hygiene and healthy eating.

However, personal hygiene practices have been noted as one of the cost-effective measures for prevention of infectious disease including COVID-19. Sekhon and Minhas, (2014), Center for Disease Control and Prevention Coronavirus (2013) WHO (2009) and Mohammed (2015), in their own conceptualization stated that, Infectious diseases can easily be contracted among school children due to overcrowded environment and inappropriate poor personal hygiene practices of the students. As a result, most students get sick, skip school and lessons and it affects their academic performance. Their reports find out that, parents spend a lot of money in hospital to treat their children from infectious diseases, and most often their students might contact infectious diseases from the school and then spread it to the family members which in turn makes the family members spending a lot of money for treatment and as well as being susceptible of risk of contracting COVID-19 or other related infectious diseases. The findings proved that, the main ways by which infectious are been contracted by students are due to overcrowded of students in their school facilities. Which this over population of students, lead to risk of infectious diseases and as well contributed to parental economic loss of money in buying of medicine for treatment of the infected child. Therefore practicing of these personal hygienic act, comes as a result of having adequate knowledge regards to it.

In addition to that, World Health Organization (WHO, 2023), confirmed on the essence of hand hygiene, by making it known to us that hand hygiene compliance is recommended as one of the key performance indicators for infection prevention and control program, patient safety and quality of health services worldwide. They also added that, appropriate knowledge and practice of hand hygiene, prevents up to 50% of avoidable infections, acquired during health care delivery, including those affecting the health work force, appropriate knowledge and practice of hand hygiene also reduces the risk on SARS-CoV-2 - the virus that causes COVID-19 - infection among health workers.

Pati, Kadam, and Chauhan (2014), reported that, hand washing with soap and clean water reduces morbidity by 44% and respiratory infections by 23%. Their report have the view that, globally, 88% of diarrhea related deaths are associated with use of unsafe water, inadequate sanitation and poor hygiene practices. Similarly, Ilesanmi (2016), stated that, a study carried out on adolescent and adult dental health, shows that oral health problems was one of the major health problems been faced by our young children and adolescents, with high percentage of 30% and 43% among Nigerians, aged 12 and 15 years, respectively, Ilesanmi (2016). Therefore, there is need for an urgent awareness of the essence of personal hygiene knowledge and practice because knowledge influences people health, through basic education and public knowledge individuals become aware of the meaning of self-protection and personal hygiene. Therefore, this study wishes to examine the knowledge and practice of personal hygiene among students in Enugu State. Hussain, Hasan, Khan, Arsalan and Tabassum (2014) contribute that good oral hygiene is an evidence for good body health, while poor oral hygiene not only affect the oral cavity but also a risk factor for initiation of many systemic diseases. The presence of dental plaque is an evidence of poor oral hygiene, which if not treated might lead to dental calculus which will further deteriorate the situation. Environmental factors such as culture, socioeconomic status, life style and diet pattern might negatively influence oral health maintenance. Beril, Füsun and Gülten (2017), on their previous report showed that 52.4% of visual-disabled women did not receive information about genital hygiene; 33.4% received information about menstrual hygiene; 34.6% received information about vaginal discharge; 38.1% had urinary tract infection; 79.8% did not go to a doctor periodically. This shows that, there are urgent need for adequate practicing of vagina health among women in order to curtail the prevalence of poor practice of unhealthy vagina hygienic practice.

Knowledge and practice are essential for actualization of a predetermined goal, therefore in order to carry out personal hygiene practice, there are need for adequate knowledge and practice. Haradanahalli, Ramya and Nitu (2019), defines hygiene as a conditions and practices that encourages maintenance of health and prevention of spread of disease. In addition, personal hygiene practices are one of the health practice in our everyday lives at schools, offices, market places and homes as it protects us from contamination of infectious diseases and keeping us with good health. That is why, personal hygiene involves the total cleaning of personal body, clothing and regular exercising of environmental sanitation for the prevention of spread of infectious diseases. Haradhan, Kumar and Mohajan (2016), opined that knowledge is a fluid mix of experience, related information and expert insight that offers a structure for evaluating and integrating new experiences and information. It initiates and is applied in the mind of a knower. Therefore, knowledge is considered as a collection of experience, appropriate information and skilled insight which offers a structure for estimating and integrating new experiences and information. In this study, knowledge of personal hygiene can be seen as an act of personal awareness on the impact of personal hygiene in the body. In the view of Vivas (2019), the prevalence of communicable diseases in developing countries especially among school children may be as a result of lack of adequate knowledge on the health benefits of personal hygiene. Therefore, in order to curtail the prevalence of communicable diseases among school children there is need for adequate practicing of personal hygiene in school.

Practice is the process of actualization of predetermined goal, through an active approach. According to kjeld (2014), practice is defined as an active process of doing or performing something which has a starting point and end point. Which now indicate that, engaging into a practical process of personal hygiene, deals with active performance of the individual. The author also opined that knowledge and practice toward individual personal hygiene practice, connote with a cognitive and psychomotor approach of ensuring proper personal health being. But in a situation where by an individual lags adequate knowledge and practice regards to personal hygiene practice, might negatively influence his good health. Nevertheless, this study is anchored on a theory that is related to the current study.

Health Belief Theory (HBT), was developed to predict health behaviors. This model propounded that, the willingness to change health behaviours is primarily based on health perceptions. Therefore, this model is a tool that most scientists use to try and predict health behaviours. This model was developed in 1950's by Irwin M. Kosenstock, Godfrey M, Hockbaum S, Stephen Kegeles and Howard Leventhal at the U.S public health. The theoretical construct of health belief model includes; perceived severity, perceived susceptibility, perceived benefits, perceived barriers, modifying variables, cue to action and self-efficacy. This theory is related to the current study because, through the knowledge emanating from this theory will serve as a guide to students on a proper ways of ensuring adequate practicing of personal hygiene for the prevention of communicable diseases. Also through this theory, students' knowledge will be enhance which may lead to knowledge gain on the implication related to negligence of practicing of personal hygiene.

Statement of the Problem

The occurrence of communicable disease among secondary school students at Enugu State was as a result of poor knowledge and practice of personal hygiene, which leads to contraction of infectious diseases like measles, chicken pox, covid-19, monkey pox and diarrhea warranted the only. During school hours majority of students have been seen neglecting adequate practice of personal hygiene, such as appropriate washing of hands before eating of snacks, sharing of school uniform with his fellow students, putting sharp object in their ears, putting dirty fingers in their mouth, bathing without soap, rubbing dirty finger in their eyes, cutting their finger nails with either their teeth or with their friends sharp object. The researcher also observed that students' poor practice on personal hygiene may be as a result of students' negligence on their personal hygiene as well as their inability to put their knowledge on personal hygiene into action.

The researcher was worried that these problem mentioned above might prevent student from living a healthy life. Therefore this study seek to answer the question on the knowledge and practice of personal hygiene among secondary school students at Enugu State?

Purpose of the Study

The purpose of this study dealt with the knowledge and practice of personal hygiene among secondary school students in Enugu State. Specifically the study sought to;

1. Find out the level of knowledge of personal hygiene practices among secondary school students in Enugu State.
2. Find out the extent of practice of personal hygiene among secondary school students in Enugu State.

Research Questions

The following research question guided the study:

1. What is the level of knowledge of personal hygiene practices among secondary school students in Enugu State?
2. What is the extent of practice of personal hygiene among secondary school students in Enugu State?

Method

Descriptive survey research design was used. The population for the study consisted of all public secondary school students in Enugu State. According to existing record there are 9900 secondary schools students in Enugu (PPSMB, 2023). The sampling size consisted of 495 secondary school students. According to Nwana (2010), if a population is in few hundred a 40% sample will be do and if many hundreds, 20% sample will do and if several thousand a 5% sample or less will be chosen. In view of the above principle, the population of the study runs in many thousand thus a 5% sample was employed to select the sample size. Thus, 495 students made up the sample for this study. The researcher used simple random sampling technique. The sample size of 495 was determined using 5%, this is because the entire population for the study was in many thousand. Ezinwa and Okoye (2015), opined that this sample technique is the fundamental sampling technique where we select a group of subjects for study from a larger population. Specifically the reliability coefficients obtained from data generated with Statistical Package for Social Sciences (SPSS) using Kuder Richardson formula and Cronbach's Alpha reliability for the internal consistency reliability, shows knowledge of personal hygiene (.85) and practice of personal hygiene (.79) respectively. Thus a questionnaire titled "Knowledge and Practice of Personal Hygiene Questionnaire (KPPHQ)" was used. Three experts validated it. The researcher administered the copies of questionnaire, with the help of three research assistants. The data collected were analyzed using frequency, percentage, mean and standard deviation. The questionnaire was rated on 4-point scale of very great extent (VGE), great extent (GE), low extent (LE) and very low extent (VLE). The decision rule was that any item that has 50% and above is regarded as knowledgeable (K) while items below 50% is regarded as not knowledgeable (NK). For the personal hygiene, any item mean from 2.50 above is regarded as high while item mean below 2.50 is regarded as low.

Results

The results of the study are presented based on the research questions that guide the study. Research Question 1**:** What is the level of knowledge of personal hygiene practices among secondary school students in Enugu State?

Table 1: Percentage Response Score on the Knowledge of Personal Hygiene Practice Among Secondary School Students in Enugu State.

n= **490**

S/N	**ITEMS:** The following are students response regarding their knowledge towards practicing of personal hygiene	**CORRECT**		**INCORRECT**		**DECI**
		F	**%**	**F**	**%**	
1	I know how to take my bath twice daily	408	83.3	82	16.7	K
2	I know the essence of blushing my teeth twice daily	100	20.4	390	79.6	NK
3	I understand the health risk of sharing my underwear	300	61.2	190	38.8	K
4	I know the benefit of keeping my kitchen and food clean	407	83.1	83	16.9	K
5	**I know the consequence of putting sharp object in ear**	400	81.6	90	18.4	K
6	I know how to wash my hands with soap and water	390	79.6	100	20.4	K
7	My parents taught me personal hygiene practice	350	71.4	140	28.6	K
8	I know the essence of washing my cloths	405	82.7	85	17.3	K
9	My teacher taught me importance of hands washing	400	81.6	90	18.4	K
10	I know the essence of bathing with a clean water	200	40.8	290	59.2	NK
11	My teacher taught me personal hygiene practice	401	81.8	89	18.2	K
	Grand Percentage		**69.8%**		**30.2%**	K

Key: % = Percentage, F = Frequency, Deci = Decision, K= Knowledgeable and NK= Not Knowledgeable

In Table 1; it shows that majority of students answered correct on items 1 (83.3%), 4 (83.1%), 5 (81.6%), 8 (82.7%), 9 (81.6%), 11 (81.8%) 6 (79.6%), 7 (71.4%), and 3 (61.2%), as their knowledge regards to personal hygiene, while few of them answered incorrect on item 2 (20.4%) and 10 (40.8%). The grand percentage on correct being 69.8%, signifies that majority of secondary school students at Enugu State are knowledgeable on personal hygiene.

Research Question 2: What is the extent of practice of personal hygiene among secondary school students in Enugu State?

Table 2: Mean Distribution of Respondents on the Extent of Students Personal Hygiene Practice.

n= **490**

S/N	**ITEMS:** The following are students response regards their personal hygiene practice	Mean $\bar{X}$	SD	Deci
1	I always take my bath twice daily	3.80	0.50	High
2	I always blush my teeth twice daily	3.21	0.68	High
3	I does not share my underwear with my siblings	1.92	0.44	Low
4	I always keep my kitchen and food materials clean	3.64	1.85	High
5	**I do not put sharp object in my ear**	1.4	0.72	Low
6	I always wash my hands with soap and water	1.4	0.56	Low
7	I does not was my hands at all	1.3	0.51	Low
8	I always wash my cloths a day after wearing it	1.2	0.47	Low
9	I always wash my hands without soap	1.2	0.51	Low
10	I always bath with clean water	1.3	0.58	Low
11	I always cut my nails and hairs	1.0	0.61	Low
	Grand Mean	**2.0**	**0.68**	**Low**

Table 2 shows that items 1 to 11 which deals with students' response regards to their personal hygiene practice. Item 1 (3.80), 2 (3.21), and 4 (3.64) shows a high practice while item 5 (4.1), 6 (4.1), 7 (1.3), 3 (1.92), 8 (1.2), 9 (1.2), 10 (1.3) and 11 (1.0) shows a low practice of personal hygiene. The grand mean of 2.0 signifies that majority of students at Enugu State do not practice adequate personal hygiene.

Summary of the Findings

Based on the findings of the study, it can be deduced that: the.

1. Students are quite knowledgeable with regards to personal hygiene.
2. Students lack adequate personal hygiene practices.

Discussion of the Findings

The findings from the study are discussed in this section. Finding revealed that the students have high knowledge of personal hygiene. This finding is supported by the study carried out by WHO (2023), whom opines that having knowledge of personal hygiene may lead to regular hygienic practices which will positively enhance the state of health individually and the society at large, while poor knowledge of personal hygiene practice is a risk factor that may lead to increase in spread of communication diseases such as coronavirus, monkey pox, chicken pox and other related communicable diseases.

Therefore, students' knowledge regards to their personal hygiene, is quite encouraging because of its health benefit, while lack of knowledge regards to it might negatively influence the health state of the students. This previous study supported the current study because both pointed out that poor knowledge of personal hygiene practice affects an individual health.

The finding revealed that few students did not know the health benefit of regular tooth brushing and bathing with clean water. This study is not in line with the study of Erich and Thomas (2019), who see oral health as the health practice towards regular brushing of the teeth in order to prevent germs or tooth decay. Taken adequate care of the teeth such as brushing at least twice daily that is once in the morning and once before bedtime, using fluoride toothpaste and a toothbrush with soft flexible bristles, avoidance of sugary food and regularly teeth examination at hospital is quite essential. Because improper oral hygiene negatively lead to risk of cavities, teeth pains, swelling, bleeding gums, infection and loose teeth etc.

Further finding shows that students personal hygiene practice are on a low extent which was the reason why few students practice this item on a high extent. This study is supported by a study carried out by Beril, Füsun and Gülten (2017), on their previous report showed that 52.4% of visual-disabled women did not receive information about genital hygiene; 33.4% received information about menstrual hygiene; 34.6% received information about vaginal discharge; 38.1% had urinary tract infection; 79.8% did not go to a doctor periodically. This shows that, there are urgent need for adequate practicing of vagina health among women in order to curtail the prevalence of poor practice of unhealthy vagina hygienic practice. Their finding supported the current finding because they shows some of those essential component of the body where personal hygiene can take place.

Also finding shows that regular taking of bath, brushing of teeth twice daily and keeping the kitchen and food material clean, are one of the personal hygiene practices always carried out by few students. This finding is not in line with the finding of (Sekhon & Minhas, 2014; Center for Disease Control and Prevention, 2013; WHO 2009; Mohammed, 2015). Whom confirmed that, infectious diseases can easily be contracted among school children due to overcrowded environment and inappropriate poor personal hygiene practices of the students which poor practice of regular bathing as well as poor personal hygiene practice escalate the risk of infectious diseases and ill health.

Conclusion

Based on the findings, the study concluded that students are very knowledgeable of personal hygiene, but putting their knowledge into physical practice are seen as the major problems that most students face, which usually contribute to the risk of infectious diseases such as covid-19, genital infections, dental health challenges and diarrhea.

Recommendations

Based on the findings, the researcher recommends that:

1. Students' knowledge as it regards to personal hygiene practice should always be appraised by the classroom teacher, for the purpose of motivating those ones that have low knowledge of personal hygiene.
2. The school management should provide all the prerequisite personal hygiene materials for the facilitation of its practice.

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AVAILABILITY AND UTILIZATION STATUS OF CLEVER BOARD AND MULTIMEDIA PROJECTORS FOR PHYSICS EDUCATION IN COLLEGES OF EDUCATION IN ENUGU STATE

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Abstract

Students' consistent poor achievements in physics have been attributed to non-availability and non-utilization of ICT resources among others. This study therefore, sought to investigate the Availability and Utilization Status of ICT Resources for Physics Education in Colleges of Education in Enugu State. The area comprised all the 8 accredited public and private Colleges of Education in Enugu State. Census survey research design was adopted for this study. No sampling was involved due to the manageable size of the population (30 physics lecturers: 21 males and 9 females). Six research questions and six null hypotheses guided the study. The instrument for data collection was a structured questionnaire, developed by the researcher, validated by three experts and trial tested on 7 physics education lecturers. The researcher administered the instrument to the physics lecturers in the public and private Colleges of Education in Enugu State. The responses were collected and Kuder-Richardson's formula-20 (K-R-20) (availability status) and Cronbach alpha (utilization status) statistics were employed to compute the internal consistency estimate of the items. The reliability coefficient obtained was 0.96, which shows that it is reliable. Research questions were answered using mean, and standard deviation. The results of the study indicated that ICT resources are available but fairly utilized by the physics lecturers for teaching and learning Physics in Colleges of Education in Enugu State. It was recommended that lecturers in the Colleges of Education in the state should make up their minds to embrace and harness the new learning systems which ICT tools brought by the emerging technologies for improving teaching and learning outcomes in schools and colleges.

Keywords: Physics, Colleges of Education, Multimedia, ICT, Availability and Utilization

Introduction

Science Education is defined as all educational processes aimed at providing unlimited opportunities for learners to understand and utilize the necessary knowledge, skills and attitudes required to operate effectively in a scientific and technological society. Science education is an integral field of study which considers both the subject matter of science discipline such as Biology, Chemistry, Physics, Agriculture, and so on, as well as the process involved in the teaching and learning of science. Science Education imparts knowledge and skills in a systematic way of processing knowledge about the physical world to the learners. For this reason, science education therefore provides knowledge-required to improve health, nutrition, family planning, environment, agriculture and industry. Science education has two broad purposes. The first purpose is to promote scientific literacy among citizens on matters directly affecting their lives and the society. It is a significant part of human culture and represents one of the pinnacles of human thinking capacity. This is essential for the sustainable development of a modern, technological society. The second purpose is to build up technological capability by equipping the future workforce with essential science-based knowledge and skills and by preparing students for scientific disciplines and science-related careers in higher education (Abubakar, 2014). By acquiring scientific knowledge, students have the opportunity to develop as independent learners utilizing personal learning and thinking skills. They also have opportunities to practice and develop functional skills in literacy, numeracy, information and communications technology (ICT). The provision of quality science education to all learners has far reaching consequences on a country's development and prospects. Practical activities in science education in general and in Physics Education in particular are regarded as one of the necessary elements to promote understanding of scientific principles for national development.

Physics as one of the science subjects deals with the study of matter, energy, and the interactions between them. Physics is the bedrock of science and technology because many of the principles on which the scientific and technological advancement depends, are direct products of Physics and cuts across all other science subjects. Researches in Physics have paved way for many brilliant inventions and discoveries. In the areas of agriculture, electricity, aviation, health, telecommunication among others, physics concepts are applied (Ugwuanyi, 2013). The knowledge of Physics equips the learners with problem-solving and decision-making skills that pave way for critical thinking and inquiry that helps in responding to radical changes in all facets of life (Bello, 2011).

The teaching and learning of Physics in Colleges of Education (COE) is aimed at training qualified and competent Physics teachers who would in turn, contribute towards nation building by teaching physics to students at the secondary school levels and tertiary education levels. Therefore, it is imperative to monitor students' achievement at the Colleges of Education so as to nip in the bud all negative factors that might affect their performances. When such factors are diagnosed and eliminated to ensure the production of the right caliber of Physics lecturers, then the aforementioned national development would be realized (Alachi, Owadara, Nwosu, Njoku & Nwokoma, 2017). For the scientific and technological development of any nation to be attained, Physics knowledge is very much required. It is therefore necessary that physics as a science subject be given the much needed attention it deserves at both secondary school levels where the foundation is laid in preparation for entry into other tertiary institutions and in COE where the students are trained as future physics teachers among other areas. Tertiary institutions in Nigerian education system include Universities, polytechnics, colleges of education and monotechnics.

Colleges of education (COE) are institutions where teachers are given professional and intensive training and are certified teachers. Colleges of education are managed by a body called National Commission for Colleges of Education (NCCE) who provides and regulates the activities of College of Education. NCCE is responsible for designing and delivering their programs and offer all subset of programs which are offered by the College of Education. Colleges of education vary in modes of operation which can be described in terms of ownership, funding, employment, payment of salaries, promotions, leave allowance, procurement of facilities among others (Adeyinka, 2010). In terms of ownership, these institutions are categorically grouped into Public and Private Institutions. Public tertiary institutions are owned by either federal or state governments while private institutions are owned by either individuals or private organizations. In the course of this study the researcher is concerned with public and private colleges of education in Enugu state; this is because COE are saddled with responsibility of preparing the basic levels of teachers in Nigerian system of Education. In Enugu state, there are eight (8) accredited Colleges of Education out of which four (4) are public and four (4) are private colleges of education. The major differences in the public and private colleges of education are as follows: In terms of Ownership and funding: Public schools are those schools that are established and owned by either federal or state government (Adeyinka, 2010). These schools are managed, financed as well as supervised by the government. They do not do this for profit making. In terms of funding and financial aid public COE have more opportunities than the private. On the other hand, private COE are owned by private individuals, private groups or organizations, to educate the students and to make profit. The owners of private COE are profit earners due to the fact that they invested their money in building, equipping, making provision for necessary facilities, and equipment, and employed competent staff, pay salaries, all for the purpose of giving quality education to students and also to make profit (Adeyinka, 2010).

Despite the crucial role physics plays in National development, the learning outcome of physics education in COE is not satisfactory. There exists evidence of poor academic performance in this subject. This was evident in the survey conducted by researcher on the level of students' achievement in selected courses in physics education. The results showed that PHY 111, PHY 112, PHY 201, PHY 211in 2018/2019, 2019/2020 and 2020/2021 academic session showed that failure rate was at the tone on 35.67%, 40% and 46.82% respectively. According to Adebayo (2012), the poor achievement of physics students at colleges of education is very appalling and attributed this failure to unavailability of ICT resources. Again, Olusola and Rotimi (2012) noted poor achievement of physics education students' and attributed the poor achievement of physics students in colleges of education to non-availability and poor usability of physics resources by Physics lecturers in colleges of education. In the same vein, Oremu (2010) stressed that the problem of poor performance in this subject will have grave effects on the society as a whole in terms of dearth of manpower in all spheres of the economy if left unsolved.

Information and Communications Technology (ICT) is an instrument that has initiated transition of emphasis from analogous education to digital research based in education (Jude & Dandkoro, 2012). ICT is an innovation with a wide range of digital pedagogical resources available nowadays for teachers and students. Broadly speaking, ICT includes all forms of educational technology in learning and teaching. E-learning comprises technology enhanced learning (TEL), internet based training (IBT), web-based training (WBT), computer based interaction (CBI), computer based training (CBT), computer-assisted instruction or computer aided instruction (CAI), online education, virtual education, virtual learning environment (VLE) which is also known as learning platforms and digital educational collaboration (DEC). The researcher stated that the use of ICT has greater benefit to students, teachers and other stakeholders as it provides access to information with the latest technologies, engage students in learning process and skills which will be useful in social life and in the world of work, promote motivation of students and teachers to engage in teaching and learning for indebt knowledge of Physics education, enhance students critical thinking, eliminate geographical barriers, support lifelong learning, reduce costs and increase efficiency at educational institutions. ICT enhances education through curriculum development design and innovation, which will put in place appropriate human and material instructional resources for effective teaching and learning of physics education in colleges of education. Application of ICT tools in teaching and learning of physics education is enhanced by the following tools internet, emails, e-library, platforms, video conference, disks, flash memories, multimedia projectors, interactive white boards (clever boards) and many more. Others are ICT software such as Word processing, Blogs, desktop publishing program, database program, spreadsheet, etc. These new ICT resources play crucial roles in virtually all areas of modern information delivery. According to Nikky (2010) ICT teaching resources are different equipment available in the classroom. The processes of teaching-learning depend upon the different types of equipment available in the teaching environment or classroom. Teaching resources are therefore all the facilities, equipment and materials utilized by the teacher in teaching the students. Ugwuanyi (2013) observed that teaching resources facilitate proper understanding by the students and discourage the act of cramming. It also makes the classroom or learning environment lively and active. In this study teaching resources refer to varieties of ICT resources used for teaching and learning physics education. According to Nguyen, Williams & Nguyen (2012), the application of ICT resources has helped to improve students' understanding and leading to greater achievement and retention of the subject matter. According to Ugwuanyi (2013), teaching resources are information carriers designed specifically to fulfill objectives in a teaching learning situation**.** In the teaching learning process, lecturers aim at maximizing learning and to achieve this, they employ varieties of teaching resources to arouse all the senses in the learning process. It is believed that the more the sense organ are involved during teaching/ learning processes, the greater the effectiveness of such teaching as the sense organs are get-way to knowledge. The application of ICT materials and equipment in the classroom helps to improve the teaching and learning and permit teachers and learners to interact effectively in a teaching and learning situation. (National Policy on Education (NPE), 2014).

Availability is presence of material criterion for repairable systems that accounts for both the reliability and maintainability properties of a component or system. Availability is defined as the probability that the system is operating properly when it is requested for use (Amesi & Yellowe, 2018). That is, availability is the probability that a resource is functioning normally and not undergoing repair when it needs to be used. Thus the researcher intends to investigate in this study the much available ICT resources in colleges of education in Enugu State.

Utilization is defined as the actual use of materials available for teaching and learning purposes. Utilization is the primary technique wherein success and performance efficiency are determined. This is especially in the case with tools and equipment. Resource utilization is an integral part of the overall management of the school (Titialoyes, 2017). This included the use of ICT and other instructional materials. In this study this refers to the use of ICT resources specifically interactive white boards (clever boards) and multimedia projectors. These two components of ICT are chosen due to its spectacular measures in ensuring effective teaching of Physics through Audio visual enhancement.

The different types and components of multimedia projectors are Cathode Ray Tube (CRT) projectors, Liquid Crystal Display (LCD) projectors, Digital Light Processing (DLP) projectors, Pico projectors, Light Emitting Diode (LED) projectors and 3-D projectors. In the same way clever boards have different types and components such as Resistive Technology boards, Electromagnetic white boards, Laser scanner, Ultrasound/ Infrared, IWB software, desktop/laptop. For physics lecturers to be able to apply ICT resources in the physics classrooms, they need to have indebt knowledge and the practical skills on ICT. Despite the development in the capacities of ICT and its impact on teaching and learning, Uchendu (2012), stated that the level of application of ICT resources in Nigerian Colleges of Education is less than five percent. The researcher therefore includes usability status of ICT resources among the variable to be investigated. In other to improve learning of Physics in Colleges of Education, the present study centred on the use of interactive white boards (clever boards) and multimedia projectors as ICT resources. This is because these resources encourage student engagement, makes the learning process more enjoyable, accommodates different learning styles, makes lesson revision more convenient and reduces classroom costs. Interactive white boards (clever boards) and multimedia projectors are among the new technological advancements that are widely used in the classroom nowadays to increase students' knowledge and motivation (Uchendu, 2012). They are ICT resources that have interactive projection display that projects the computers video output. It operates with the combination of the interactive whiteboard, a computer, a projector, and Smart Board software. The projection screen is available as a white board or as a display frame that fits over a plasma screen. The board can either be mounted or portable. The device is touch screen that allows the operator to manipulate content with the touch of a finger. Interactive white boards (clever boards) and multimedia projectors were preferred over the others because they are very easy to use. The boards do not use chalk or markers (which can be messy); it only uses finger or a special pen (Uchendu, 2012). It provides students with an enriched learning experience by projecting visual elements. It also makes learning much easier because lecturers are able to accommodate different learning styles. In addition to that, a student's learning experience is also enhanced by this technology because of its ability for students to view diagrams, charts, videos, and more right on the huge screen in front of them. Their learning comes to life, and many students find it more fun to learn than ever before.

National Policy on Education (NPE, 2014) opined the use of interactive white boards (clever boards) in the classroom can make a difference for students who have trouble with thinking abstractly in abstract subjects, because it makes the teaching/ learning process more concrete, when using the features of the interactive white boards (IWBs) (Uchendu, 2012). The potential benefits of clever boards for teaching also are: flexibility and versatility, multimedia/ multimodal presentation, efficiency, supporting planning and the development of resources, modeling information and communication technologies skills, interactivity and lesson participation. Also, they find the unique features of IWBs relate to the promotion of students' learning skills (Ruhul, Mahedi and Abul, 2018). The use of Multimedia projector in the class enables lecturers to deliver a topic not only verbally but also visually which offers much supportive for students and gives room for more concentration in the class. Students are also able to discuss together between the verbal and non-verbal as well as theoretical and material issues (Ruhul, *et al*., 2018). Therefore, this study seeks to examine the availability and utilization of ICT resources in teaching and learning physics education in colleges of education in Enugu State, Nigeria irrespective of gender.

Gender has been noted by researchers over the years as having impact on achievement in Physics and its related disciplines (Akumah, 2013). Akumah even stressed that science, technology and their related disciplines are male-reserved while Art and Humanities are female reserved. This belief makes boys appear to have a natural positive attitude towards science and technical subjects while girls show more inclination to Arts and Humanities. The problem is even compounded by the fact that most science educators give masculine outlook to science subjects such as chemistry and physics (Akuma, 2013); encouraging females to go rather for biology, agricultural science and home economics which they consider to be more female-friendly science subjects. Unegbu, Ogugua, Nnadimele and Nse (2019) noted that male lecturers in the institutions of higher learning embrace the use of ICT resources more than their female counterparts.

Also, Agnetha (2005) opined that generally females had negative attitudes towards the use of ICT resources. Several studies have examined the use of ICT resources with respect to gender differences in proficiency. According to Mumporeze and Prieler (2017), females lecturers have limited access to ICT resources than their male counterparts and that males generally are more ICT competent than their female counterparts. Again, studies of Lee, Czaja, Moxley, Sharit, Boot, Charness and Rogers (2019); and Tam, Chan and Lai (2020), observed that female showed more proficiency in the use of ICT in teaching and learning. Based on the differences in the opinion of researchers, there is need for inclusion of gender as a variable in this study to further shed light on the controversial gender difference in ICT proficiency. Furthermore, availability of ICT resources is observed to depend on the large extent of school type and ownership of secondary schools in Enugu State.

School type can be described as those variables that constitute the ownership of a school in a given community. The ownership of schools is predominantly of two categories: Public and Private Ownership. Public secondary school are the types of schools owned and managed by the government; while private schools are the schools that are owned and managed by private individuals or partners with common interest and goal. According to Abubakar (2014), the availability or absence of ICT for teaching and learning of biology is purely dependent on the ownership of the school. School type has direct influence on classroom use of ICT-based instructional strategies such as resources availability (human and material); school ICT culture and community participation which is clearly determined by school type (Ugwuanyi, 2013). Human resources such as computer technicians, computer experts among others, and material resources such as computer hardware and software, well-equipped computer laboratory, projectors and portable screen are prior demonstration of school culture on interest and essential to provide motivation and encouragement that can influence teachers to adopt ICT-based instructional strategies into classroom teaching of biology. Ugwuanyi (2013) maintained that training programme for staff on ICT proficiency is a demonstration of desire accorded to school type. Tinio (2012) highlighted the importance of infrastructural facilities that is linked with school culture. School culture can be defined as the set of shared values, beliefs and norms that influence the way educators and administrators think, feel, and behave in school place (Agyei, 2013). School ICT culture refers to the school tradition in using computer- based technology for administrative and academic activities in the school. For example; use of e-mail and text messages to communicate with the staff and students, accessing students and important school programmes online through school portal. Such a tradition will provide stimulating environment for use of ICT-based instructional strategies. From the available literature, and to the best knowledge of the researchers, not much works have been done on availability and usability status of ICT resources for physics education in COE in Enugu state. Therefore, this work is poised determine the availability and utilization of ICT resources in teaching and learning of physics in Colleges of Education in Enugu State.

Statement of the Problem

The Scientific and technological development of any nation depends on the level of scientific skills possessed and utilized by her citizens. This is why Science education of the 21st century should adopt life competencies as part of innovation in a digital age science education. For the scientific and technological development of any nation to be attained, Physics knowledge is very much required. Despite the crucial role physics plays in the education and training of future physics teachers, there is a decline in achievement in physics in Colleges of education. Some researchers attributed the poor achievement of physics students in colleges of education to non-availability and poor usability of ICT resources by Physics lecturers in colleges of education. Some attributed it to low level of ICT proficiency by physics lecturers in the colleges of education. Other researchers argued that school type and gender of the lecturers are the major factors hindering available and usability of the ICT resources for teaching physics in colleges of education. This lingered problem has resulted in low enrollment of physics students in colleges of education; and consequently resulted to poor proficiency of physics education graduates in colleges of education. In view of the on-going, the present study identifies availability and utilization of ICT resources for teaching physics whose impart in teaching and learning physics in colleges of education in Enugu State have not been so much reported in the literature. Therefore, the problem of this study is put in a question form "What is the availability and utilization of ICT resources for teaching physics in colleges of education in Enugu State?

Purpose of the Study

The purpose of the study was to determine the availability and utilization status of Clever board and multimedia projectors for teaching and learning of physics Education in public and private Colleges of Education in Enugu State. Specifically, the study sought to determine the:

1. Availability status of clever board for teaching and learning Physics in public and private Colleges of Education in Enugu State.
2. Availability status of multimedia projectors for teaching and learning Physics in public and private Colleges of Education in Enugu State.
3. Utilization status of clever board for teaching and learning Physics in public and private Colleges of Education in Enugu State.
4. Utilization status of multimedia projectors for teaching and learning Physics in public and private Colleges of Education in Enugu State.

Research Questions

The following research questions guided the study.

1. What is the mean of the availability status of clever boards for teaching and learning Physics in public and private Colleges of Education in Enugu State?

2. What is the mean of the availability of multimedia projectors for teaching and learning Physics in public and private Colleges of Education in Enugu State?
3. What is the utilization of clever board in teaching and learning Physics in public and private Colleges of Education in Enugu State?
4. What is the utilization of multimedia projectors in teaching and learning Physics in public and private Colleges of Education in Enugu State?

Method

The study employed a census survey research design. A census survey research design is one which data is collected from every member of the population studied (Nworgu, 2018). The census survey research design was considered most appropriate for this study because it provides a complete view of all the members of the population under study. The study was carried out in Enugu state. Enugu State is one of the states in the Eastern part of Nigeria located at the foot of the Udi Plateau in the South Eastern geopolitical zone. Enugu State is made up of 17 local government areas. Enugu State shares borders with Abia and Imo states in the South, Ebonyi state in the East, Kogi in the Northwest and Anambra state in the Western part of Nigeria. Enugu state has six education zones namely Agbani, Awgu, Enugu, Nsukka, Obollo Afor and Udi education zones. Enugu State has eight colleges of education, encompassing both public and private colleges of education, universities, polytechnics and many secondary schools. The considerable large number of the colleges of education and other institutions of learning in the state depict that the people in the area like education and are mostly civil servants.

The researcher chose Enugu state due to the fact that most of the colleges of education have qualified physics lecturers, laboratories, ICT tools and other instructional materials and yet students experience difficulties in answering questions in physics in their examinations. The population for the study was made up of 30 physics lecturers who are currently serving in eight Colleges of Education (COE) in Enugu State. Among whom are 21 male lecturers and nine (9) female lecturers. Also 20 physics lecturers are teaching in public COE and 10 are in Private COE. The entire population constituted the sample size used for the study due to the fact that the population is small and manageable. Hence, there was no sampling. The instrument for data collection for this study was a structured questionnaire adapted from NCCE checklist, the response option was increased from 2 to 4. The researcher named the instrument “Availability and Utilization Status of ICT Resources for Physics Education Questionnaire” (AUSICTRPEQ) besides the researcher’s direct observations. Direct observations with the checklist were used by the researcher in determining the availability status of ICT resources for effective teaching and learning of physics in COE in Enugu State. The researcher adapted items 1- 46 because of its relevance to clever board and multimedia projectors as major components of the study. The (AUSICTRPEQ) consisted of Ninety-two (92) item based on research questions 1-4. The (AUSICTRPEQ) was arranged in two sections of Section A and Section B. Section A concerned with the personal/ demographic data of the respondents. The information that was supplied by the respondents in this section A was used in answering research questions 5-10 and testing the hypotheses. Section B was concerned with the data required for answering the research questions 1-4. Section B consisted of a total number of 54 items arranged in four (4) clusters based on research questions 1-4.

Clusters 1 and 2 have 25 and 21 items per cluster respectively with two response options of A (Available) or NA (Not- Available). These clusters were concerned with Available ICT resources for use by Physics lecturers in teaching and learning physics in COE while clusters 3 and 4 will be a rating scale and was concerned with the extent of utilization of the available ICT resources by physics lecturers in teaching and learning physics. Specifically ,clusters 3 and 4 consists of 25 and 21 items per cluster respectively with four points rating scale response options of VHE- Very high extent, HE- High extent, LE- Low extent, VLE- Very low extent. The instruments were validated by three experts from ESUT. The instruments were tested for internal consistency reliability using Kuder-Richardson- 20 and Cronbach's alpha which yielded a coefficient of 0.98 and 0.96 indices respectively for availability and utilization items. The instrument was distributed to the respondents upon selection through the help of the research assistants who doubled to be their physics teachers in their respective schools. Research questions 1 and 2 were answered using mean, and Standard deviation. This was appropriate because it has only two options of Available or Not available. The mean responses that was greater than zero was rated as positive (available) while mean scores less than or equal to zero was rated as negative (Not available). Research questions 3-10 was answered using mean and standard deviation responses with values of 4,3,2 and 1 for very high extent (VHE), high extent (HE), Low Extent (LE), Very Low Extent (VLE) respectively was assigned to responses from which a mid-point mean value was calculated. Hypotheses were tested using t-test statistics. The choice of t-test is because more than one group was involved (school type and gender).

Results

Research Question 1:

What is the mean of the availability status of clever boards for teaching and learning Physics in public and private Colleges of Education in Enugu State?

Table 1: Mean and Standard deviation of Availability status of Clever board for teaching and learning of Physics in Colleges of Education in Enugu State

S/N	Items	Mean ( )	SD	Status
1	Resistive Technology boards	0.30	0.47	FA
2	Electromagnetic white boards	0.73	0.45	HA
3	Electronic graphics board	0.00	0.00	NA
4	Magnetic cards for recording	0.70	0.47	HA

5	Mobile communication gadgets such as iPad, itouch	0.87	0.35	HA
6	Electronic readers	0.00	0.00	NA
7	Fax machine	0.03	0.18	FA
8	Mobile resources such as MP3, MP4, MP5 etc	0.87	0.35	HA
9	Laser scanner	0.03	0.18	FA
10	Ultrasound /Infrared	0.13	0.35	FA
11	IWB Software	0.33	0.48	FA
12	Desktop Computers	0.97	0.18	HA
13	UPS	0.47	0.51	A
14	e- library containing Physics text books	0.93	0.25	HA
15	CD-ROMs	0.63	0.49	A
16	Stylus Pen	0.67	0.48	A
17	Android Cell Phone	1.00	0.00	HA
18	Television set	0.53	0.51	A
19	Alternative Power Supply	1.00	0.00	HA
20	Podcasts and streaming such as podcast, iLecture etc.	0.07	0.25	FA
21	Shared documents e.g. SlideShare, Google Docs etc.	0.67	0.48	A
22	Computer software such as MS excel, MS word etc.	1.00	0.00	HA
23	Optical	0.03	0.18	FA
24	Flash memories	0.40	0.50	A
25	Audio and video disc	0.43	0.50	A
	Grand Mean/ SD	**0.50**	**0.29**	**A**

Key: SD = Standard Deviation, HA = Highly Available, A = Available, FA = Fairly Available, NA = Not Available

The data presented in Table 1 reveals that items 3 and 6 have means of 0.00, indicating that the items are not available for teaching and learning of Physics in Colleges of Education in Enugu State. In the same vein, the means of items 1, 7, 9, 10, 11, 20 and 23 have means ranging from 0.01 – 0.39, indicating that the clever board of ICT tools are fairly available for teaching and learning of Physics in Colleges of Education in Enugu State. Again, the means of items 13, 15, 16, 18, 21, 24 and 25 have means ranging from 0.40 – 0.69, indicating that the clever board of ICT are available for teaching and learning of Physics in Colleges of Education in Enugu State. Furthermore, the means of items 2, 4, 5, 8, 12, 14, 17, 19 and 22 have means ranging from 0.70 -1.00, indicating that the clever board of ICT are highly available for teaching and learning of Physics in Colleges of Education in Enugu State. Generally, the grand mean of the items is 0.50, indicating that clever board is available for teaching and learning of Physics in Colleges of Education in Enugu State. Table 1 also shows that the Standard deviations (SD) of all the items are within the range of 0.00 to 0.51 and are positive which indicates that the respondents were not very far from one another in their responses.

Research Question 2:

What is the mean of availability of multimedia projectors for teaching Physics in teaching and learning Physics in Colleges of Education in Enugu State?

Table 2: Mean and Standard deviation of Availability status of Multimedia projector for teaching and learning of Physics in Colleges of Education in Enugu State

S/N	Items	Mean ( )	SD	Status
26	Cathode Ray and learning Tube (CRT) projectors	0.03	0.18	FA
27	Liquid Crystal Display (LCD) projectors	0.00	0.00	NA
28	Digital Light Processing (DLP) projectors	0.97	0.18	HA
29	Pico projector	0.00	0.00	NA
30	Light Emitting Diode (LED) projectors	0.13	0.35	FA
31	3 –D projectors	0.00	0.00	NA
32	Overhead projector	0.97	0.18	HA
33	USB Flash	0.53	0.51	A
34	Portable Video games	0.47	0.51	A
35	DVD	0.97	0.18	HA
36	Internet Connection Modem	1.00	0.00	HA
37	Laptops	1.00	0.00	HA
38	Audio System	0.47	0.51	A
39	Digital cameras	1.00	0.00	HA
40	Transparencies	0.13	0.35	FA
41	Wiki such as wikispaces, wikipad, Wikipedia	0.27	0.45	FA
42	Digital Repositories e.g. Google scholar, YouTube,	0.70	0.47	HA
43	Assessment and survey tools e.g. Exam & Quiz Builder	1.00	0.00	HA
44	Asynchronous communications e.g. email, forums	0.97	0.18	HA
45	Synchronous communications e.g. Google talk, iChat	0.43	0.50	A
46	Satellite	0.70	0.47	HA
	GRAND MEAN/ SD	**0.56**	**0.24**	**A**

The data presented in Table 2 reveals that items 27, 29 and 31 have means of 0.00, indicating that the items of multimedia projectors are not available for teaching and learning of Physics in Colleges of Education in Enugu State. In the same vein, the means of items 26, 30, 40 and 41 have means ranging from 0.01 – 0.39, indicating that the multimedia projectors of ICT tools are fairly available for teaching and learning of Physics in Colleges of Education in Enugu State. Again, the means of items 33, 34, 38 and 45 have means ranging from 0.40 – 0.69, indicating that the multimedia projectors of ICT are available for teaching and learning of Physics in Colleges of Education in Enugu

State. Furthermore, the means of items 28, 32, 35, 36, 37, 39, 42, 43, 44 and 46 have means ranging from 0.70 -1.00, indicating that the multimedia projectors of ICT are highly available for teaching and learning of Physics in Colleges of Education in Enugu State. Generally, the grand mean of the items is 0.56, indicating that multimedia projector is available for teaching and learning of Physics in Colleges of Education in Enugu State. Table 2 also shows that the Standard deviations (SD) of all the items are within the range of 0.00 to 0.51 and are positive which indicates that the respondents were not very far from one another in their responses.

Research Question 3:

What is the utilization of clever board in teaching and learning of Physics in public and private Colleges of Education in Enugu State?

Table 3: Mean and Standard deviation of Utilization status of clever board for teaching and learning of Physics in Colleges of Education in Enugu State

S/N	Items	Mean ( )	SD	Status
47	Resistive Technology boards	1.55	0.78	FU
48	Electromagnetic white boards	2.17	0.80	U
49	Electronic graphics board	1.21	0.49	FU
50	Magnetic cards for recording	2.48	0.99	U
51	Mobile communication gadgets such as iPad, itouch	2.03	0.33	U
52	Electronic readers	1.17	0.38	FU
53	Fax machine	1.21	0.41	FU
54	Mobile resources such as MP3, MP4, MP5 etc	2.55	0.63	U
55	Laser scanner	1.59	0.91	FU
56	Ultrasound /Infrared	1.52	0.83	FU
57	IWB Software	1.93	0.88	FU
58	Desktop Computers	2.76	0.83	U
59	UPS	1.69	0.76	FU
60	e- library containing Physics text books	2.10	0.62	U
61	CD-ROMs	2.14	0.74	U
62	Stylus Pen	2.72	1.10	U
63	Android Cell Phone	3.41	0.68	HU
64	Television set	2.41	0.63	U
65	Alternative Power Supply	2.41	0.91	U
66	Podcasts and streaming such as podcast, iLecture etc.	1.34	0.61	FU
67	Shared documents e.g. SlideShare, Google Docs etc.	2.28	0.92	U
68	Computer software such as MS excel, MS word etc.	2.41	0.68	U
69	Optical	1.21	0.56	FU
70	Flash memories	1.72	0.88	FU
71	Audio and video disc	1.62	0.82	FU
	Grand Mean/ SD	**1.99**	**0.73**	**FU**

Key: SD = Standard Deviation, HU = Highly Utilized, U = Utilized, FU = Fairly Utilized, NU = Not Utilized.

The data presented in Table 3shows that items 47,49, 52, 53, 55, 56, 57, 59, 66, 69, 70 and 71 have means ranging from 1.0 – 1.9, indicating that the clever board of ICT resource are fairly utilized for teaching and learning of Physics in Colleges of Education in Enugu State. In the same vein, the means of items 48, 50, 51, 54, 58, 60, 61, 62, 64, 65, 67 and 68 have means ranging from 2.0 – 2.9, indicating that clever board of ICT resources are utilized for teaching and learning of Physics in Colleges of Education in Enugu State. Again, the item 63 has mean range of 3.0 – 4.0, indicating that clever board is highly utilized for teaching and learning of Physics in Colleges of Education in Enugu State. Generally, the grand mean of the items is 1.99, indicating that clever board is fairly utilized for teaching and learning of Physics in Colleges of Education in Enugu State. Table 2 also shows that the Standard deviations (SD) of all the items are within the range of 0.33 to 1.10 and are positive which indicates that the respondents were not very far from one another in their responses.

Research Question 4:

What is the extent of utilization of multimedia projectors in teaching and learning Physics in Colleges of Education in Enugu State?

Table 4: Mean and Standard deviation of Utilization status of multimedia projector for teaching and learning of Physics in Colleges of Education in Enugu State.

S/N	Items	Mean ( )	SD	Status
72	Cathode Ray Tube (CRT) projectors	1.48	.57	FU
73	Liquid Crystal Display (LCD) projectors	1.45	.51	FU
74	Digital Light Processing (DLP) projectors	2.03	.82	U
75	Pico projector	1.14	.44	FU
76	Light Emitting Diode (LED) projectors	1.31	.47	FU
77	3 –D projectors	1.66	.77	FU
78	Overhead projector	1.90	.77	FU
79	USB Flash	2.21	1.08	U
80	Portable Video games	1.72	.59	FU
81	DVD	2.21	.62	U
82	Internet Connection Modem	2.69	.66	U
83	Laptops	2.66	.67	U
84	Audio System	2.24	.95	U
85	Digital cameras	2.31	.85	U
86	Transparencies	1.55	.78	FU
87	Wiki such as wikispaces, wikipad, Wikipedia	1.48	.78	FU

88	Digital Repositories e.g. Google scholar, YouTube,	2.31	1.04	U
89	Assessment and survey tools e.g. Exam & Quiz Builder	3.14	.52	HU
90	Asynchronous communications e.g. email, forums	2.45	.63	U
91	Synchronous communications e.g. Google talk, iChat	1.72	.84	FU
92	Satellite	2.00	.80	U
	Grand Mean/ SD	**1.98**	**0.72**	**FU**

The data presented in Table 4 shows that items 72, 73, 75, 76, 77, 78, 80, 86, 87 and 91 have means ranging from 1.0 – 1.9, indicating that the multimedia projectors of ICT resource are fairly utilized for teaching and learning of Physics in Colleges of Education in Enugu State. In the same vein, the means of items 74, 79, 81, 82, 83, 84, 85, 88, 90 and 92 have means ranging from 2.0 – 2.9, indicating that multimedia projectors of ICT resources are utilized for teaching and learning of Physics in Colleges of Education in Enugu State. Again, the item 89 has mean range of 3.0 – 4.0, indicating that multimedia projector of ICT is highly utilized for teaching and learning of Physics in Colleges of Education in Enugu State. Generally, the grand mean of the items is 1.98, indicating that multimedia projectors are fairly utilized for teaching and learning of Physics in Colleges of Education in Enugu State. Table 4 also shows that the Standard deviations (SD) of all the items are within the range of 0.44 to 1.08 and are positive which indicates that the respondents were not very far from one another in their responses.

Discussion of the Findings

The findings of the study revealed that the grand mean of the items is 0.50, indicating that the Clever Board is available for teaching and learning physics in Colleges of Education in Enugu State. The findings of the study also showed that the standard deviation (SD) of the items are within the range of 0.00 – 0.50 and are positive, which indicates that the respondents were homogenous in their responses. This finding is in tandem with Kiptalam and Rodriguess (2011) who stated that the integration of the new technology into education is exceedingly reliant on the accessibility and availability of the resources in schools. The findings of this study disagrees with Leach (2008), Nwana (2007; 2008b and 2012) that the new information and communication technologies (ICTs) needed for achieving the goals of education for all are not available. They noted that the new technologies needed for effective ICT implementation in schools are not available. Again, the findings does not aligns with Jegede and Owolabi (2008) that there is dearth of infrastructural facilities for the teaching of computer Education and general science. The finding disagrees with the Global ICT Report (2012) that Nigeria ranked 112 out of 142 countries surveyed for network readiness to participate and benefit from ICT development.

The findings showed that the grand mean of the items is 0.56, indicating that multimedia projector is available for teaching and learning physics in colleges of education in Enugu State.

The findings of the study also revealed that the standard deviation (SD) of all the items are within the range of 0.00 -- 0.51 and are positive which indicate that the respondents were not very far from one another in their responses. This finding is in agreement with Samaila et al (2021) who posited that the availability and integration of interactive multimedia tools in effective teaching and learning helps students to improve their understanding in various abstract subjects such as physics. The findings of this study disagrees with Leach (2008), Nwana (2007; 2008b and 2012) that the new information and communication technologies (ICTs) needed for achieving the goals of education for all are not available. They noted that the new technologies needed for effective ICT implementation in schools are not available. Again, the findings does not aligns with Jegede and Owolabi (2008) that there is dearth of infrastructural facilities for the teaching of computer Education and general science. The finding disagrees with the Global ICT Report (2012) that Nigeria ranked 112 out of 142 countries surveyed for network readiness to participate and benefit from ICT development.

The findings of the study revealed that the grand mean of the items is 1.99, indicating that the Clever Board was fairly utilized for teaching and learning of physics in colleges of education in Enugu State. Further, analysis showed that the standard deviations of all the items are within the range of 0.033 to 1.10 and are positive which indicates that the respondents were homogenous in their responses. This is in agreement with Gilaktejani (2012) who stated that when student's interest increases, understanding, becomes enhanced and retention ability increased, there is the tendency for an improvement in academic achievement of the students. This finding disagrees with the findings of Ololube (2006) and Pelgrum (2012) that observed that there is poor ICT resources integration and usage in the school system for taching and learning purposes. Again, the finding is not in conformity with Pumer (2011) and Nwana (2008b) that the teachers lack the necessary skills and competencies in the use of ICT resources for teaching and learning of science subjects. The finding is also in discord with Amedu (2014) that secondary school teachers lack the skills to fully utilize e-learning technology in curriculum implementation hence, the traditional chalk and duster approach still dominate in secondary school pedagogy, meanwhile the study provided that lecturers in colleges of Education have possessed necessary skills and implement ICT integration.

The findings revealed that the grand mean of all the items is 1.98, indicating that multimedia projector are fairly utilized for teaching and learning of physics in colleges of education in Enugu State. Further analysis of the study revealed that the standard deviations of all the items are within the range of 0.44 – 1.08 and are positive which indicated that the respondents were not very far from each other in their responses. This finding correlates with the discovery of Fakeye (2010) that most Colleges of Education in Nigeria are not well prepared for the utilization of ICT resources. This finding disagrees with the findings of Ololube (2006) and Pelgrum (2012) that observed that there is poor ICT resources integration and usage in the school system for teaching and learning purposes. Again, the finding is not in conformity with Pumer (2011) and Nwana (2008b) that the teachers lack the necessary skills and competencies in the use of ICT resources for teaching and learning of science subjects. The finding is also in discord with Amedu (2014) that secondary school teachers lack the skills to fully utilize e-learning technology in curriculum implementation hence, the traditional chalk and duster approach still dominate in secondary school pedagogy, meanwhile the study provided that lecturers in colleges of Education have possessed necessary skills and implement ICT integration.

Conclusions/Recommendations

The study is centered on the availability and utilization status of ICT Resources for Physics Education in Colleges of Education in Enugu State. In view of the findings of this study, the following conclusions were drawn In view of the learning effectiveness and benefits of clever boards in the classroom; it is recommended that all teachers particularly the physics teachers are encouraged to be using the clever boards in the classroom. Physics textbooks authors should develop books that will reflect the use of ICT tools with teacher's guides. Government and relevant professional associations should sponsor further research on the effectiveness of use of ICT Resources (clever board and multimedia projectors) in enhancing students' academic achievements in physics and other science subject. As new innovation, teachers should be properly taught how to use the new technology.

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EFFECTS OF INQUIRY BASED TEACHING STRATEGY AND GENDER ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN STEREOCHEMISTRY IN ENUGU EDUCATION ZONE

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Abstract

The students' consistent low performance in internal and external examinations undermined the efficacy of chemistry teachers' methods of instruction. Thus, the purpose of the research is to find out how inquiry-based learning can impact students' academic achievement in stereochemistry in Enugu education zone. The study was guided by two research questions and three research hypotheses. The study employed a pretest-posttest non-equivalent control group design. 4,532 SS2 Chemistry students made up the study's population. A combination of random and purposive sampling procedure was used to select 96 students. While the control group received instruction via lectures, the experimental group was taught using an inquiry-based teaching strategy. The Chemistry Achievement Test (CAT) was the instrument used for data collection, and its reliability index was evaluated using Kuder-Richardson's formula-20 which yielded coefficient of 0.84. The mean, standard deviation, and analysis of covariance were used to analyze the data. The findings demonstrated that students exposed to the inquiry-based teaching strategy outperformed their peers who received instruction via lectures. For improved students' achievement, it was recommended that Chemistry teachers should use inquiry based teaching strategy when teaching chemistry.

Keywords: Inquiry-Based teaching, Chemistry, achievement, Gender and Stereochemistry.

Introduction

Science is a disciplined body of knowledge that investigates nature in a testable and verifiable way using a methodical methodology. Broadly speaking, science before the modern period and was present in many ancient cultures. Science does not engage with supernatural explanations; instead, it only considers the natural world (Igboegwu, 2012). It is a means of gaining knowledge about the elements of the natural world, including people, societies, ecosystems, animals, plants, rivers, seas, deserts, mountains, soils, air, and every other element of the physical universe. According to Wilson (2012), science is a methodology of knowledge acquisition that organizes a body of information using the scientific process or method. According to Onah and Nwankwo (2024), science is a trustworthy method of education that verifies theories using information obtained from the natural world (Onah & Achufusi, 2022). According to Idoko (2014), science is the dynamic and objective process of learning about nature that produces new discoveries and insights into the recurring themes in ideas. According to Ezeano (2013), science is composed of three fundamental subjects: biology, chemistry, and physics.

The study of matter's makeup, characteristics, and behavior in a particular environment is known as chemistry. Atoms and how they interact with one another, especially the characteristics of chemical bonds, is the subject of chemistry. Chemistry is a scientific discipline that methodically examines the characteristics, makeup, and functions of both organic and inorganic substances. In school science curricula designed for pupils thinking about a career in science, chemistry is a major subject. According to Helmenstine (2012), this field of study connects other natural sciences including physics, geology, and biology, earning it the moniker "the central science." Chemistry is a discipline of science that deals with identifying the substances that make up matter (Bagley, 2017). According to Okon (2012), chemistry has been recognized as a highly significant scientific stem. It has been well documented how vital it is to the particular and technical advancement of any country. Chemistry was made a core subject among the physical sciences and a requirement for studying many science-related courses like medicine, pharmacy, biochemistry, nursing, engineering, industrial Chemistry, anatomy, etc. In Nigerian’s institution due recognition has been given to Chemistry for the development of man and his environment. Stereochemistry being a key topic in the scientific curriculum at school, chemistry permeates every aspect of our daily lives (Eze & Omeje, 2023). When we breathe, eat, or read, chemicals respond. The scientific field of chemistry has contributed to the growth of the following industries: cement; pharmaceuticals; clothes through the textile industry; transportation; cleanliness; control of air and water pollution; and agriculture, which produces food and facilitates agricultural activities more quickly and easily. Students may learn about the scientific method and develop their critical thinking, logical reasoning, problem-solving, and communication abilities by studying chemistry (Durukan, 2011). Early and efficient chemistry instruction may boost students' academic performance and provide them with a wide range of transferable abilities that they can use in their future employment. For attainment of these careers in chemistry, it is important to have grasped knowledge of arrangement of atoms and molecules like in the concept of stereochemistry.

Stereochemistry is the study of the relative arrangement of atoms in molecules and their manipulation. A major area of stereochemistry is the study of isomers which is introduced below. Isomers are species with the same atoms in the same numbers, i.e., the same molecular formula but are arranged differently in space. Constitutional isomers have a different sequence of bonds that may result in another skeleton, i.e., skeletal isomers, different reactive features: functional groups isomers, or the same reactive features but placed at different locations-positional isomers. Stereochemistry explores the complex world of atom placement inside molecules and the techniques used to change these configurations. One of the most important aspects of this field is the study of isomers, which are molecules with the same atomic makeup but different spatial arrangements. These differences fall into a number of categories, each of which illuminates a distinct facet of molecular behavior and structure. One of the fundamental classes in isomeric research is constitutional isomers. These molecules exhibit differences in their bonding sequences, which may result in modifications to the underlying skeleton. These differences might show up as skeletal isomers, which have different molecular arrangements at the core and hence different molecular shapes and characteristics. Conversely, differences in the functional groups of constitutional isomers might result in its formation, functional group isomers, which have different chemical re-activities and characteristics, may arise from constitutional isomers that display differences in their functional groups. Furthermore, reactive groups within molecules might occupy distinct spatial locations, which can influence their behavior and interactions during chemical reactions, giving rise to positional isomers. Consequently, the study of isomers reveals the significant influence of spatial arrangements on chemical characteristics and reactivity in addition to the intricacy of molecular architecture. This idea has a big influence on actual life as it makes it possible to meet fundamental needs on a regular basis through production of useful substances like polytene.

Despite chemistry's importance to national development, academic achievement in the subject often falls short of the expectations. Academic achievement is defined as a student's scholastic standing at a given moment, reflected through grades and performance on educational tests, as well as cumulative indicators like degrees and certificates (Eze & Omeje, 2023). An examination conducted by West African Examinations Council (WAEC) for senior secondary school (SSS) Chemistry students' revealed that students’ performance in Nigeria specifically Enugu State is consistently below the expectation in the subject. For instance, in the 2022 West African Examinations Council (WAEC) session, out of the total 71,452 candidates who registered and sat for the examination in Enugu state, only 16,077 students, representing 22.5%, passed Chemistry at the credit level. In the subsequent years, the trend persisted. In 2023, there was a further decline in the number of students passing, with only 20.7% achieving credit and above. This was made more evident in Joint Admission and Matriculation Board (JAMB), 2024 as it showed that about 85.5% of the candidates that sat the examination scored below 50%. Despite some improvements, student achievement in chemistry remains generally unfavorable in Enugu education zone. The WAEC Chief Examiner noted that many students struggled with questions on stereochemistry due to their inability to apply concepts. The examiners attributed poor performance to the prevalent use of the lecture method, which lacks opportunities for practical application. According to Onah (2023), the teachers poor instructional approach has been accounted for students’ poor achievement in physics in particular and science in general. This poor instructional approach has been engulfed with traditional lecture method.

The traditional lecture method is a type of instruction that uses speaking and chalk pedagogy to effectively impart thoughts and ideas to pupils. It does not, therefore, encourage genuine learning. This method places a strong emphasis on textbooks and workbooks for curriculum exercises. Even when pupils don't grasp the key ideas, the majority of teachers still follow it (Ibe & Abonyi, 2014). Among the characteristics of the traditional lecture techniques are: Science instructors in Nigeria have embraced rote memorization of textbooks and other materials, excessive chatting, and note copying after the class. Once again, the traditional lecture method uses an expository approach to teaching rather than an inquiry-based approach, which does not only bias students toward hands-on learning activities but rather piques their curiosity about science and the teaching process that foster forensic learning of chemistry (Duran, 2011)

Inquiry based learning is a teaching strategy where the teacher answers students' questions with guiding counter-questions instead of giving them direct answers. Inquiry-based learning (IBL) was once intended to be a classroom-based approach to teaching with the goal of raising students' chemistry achievement. The first step in inquiry-based learning is to pose queries, issues, or scenarios. Students' enthusiasm to learn and their comprehension of the nature of science are both enhanced by the inquiry-based learning approach. Additionally, it fosters students' capacity for inquiry, which is a crucial component of lifelong learning. Given the importance of inquiry in education in the twenty-first century, Nigeria, a developing nation, has not lagged behind in implementing inquiry-based learning strategies and guaranteeing gender parity in all facets of the teaching and learning process (Ghumdia, 2016). The major goals are to include students and help them comprehend strategic concepts for industrial development (Dushimimana & Mugabo, 2022). Making inquiries about novel solutions and problems when you are learning new knowledge is made possible via inquiry. In IBL, questions are developed, observations are made, research is conducted to determine what information is already recorded, experimentation techniques are developed, instruments for data collection are developed, data is collected, analyzed, and interpreted, potential explanations are outlined, and predictions are made for further study. According to Sola and Ojo (2017), Problem-based learning is a component of inquiry-based learning, which is typically used to small-scale studies and projects. The development and use of thinking abilities is most directly linked to inquiry-based education (Oluchukwu, 2016). A facilitator frequently offers assistance to the process. In order to expand their knowledge or find answers, inquirers study problems and questions. Problem-based learning is a component of inquiry-based learning, which is typically applied in small-scale projects and research. The development and use of thinking abilities is most tightly linked to inquiry-based training. Inquiry-based learning is divided into three categories by Cheval and Hart (2005). According to Ghumdia (2016), structured inquiry, guided inquiry, and open inquiry are forms of inquiry teaching strategy used for teaching science. When taught properly, any of these inquiry methods may help children learn science. Guided inquiry will be employed in this investigation. The process of inquiry learning promotes students' understanding and achievement of the nature of science as well as the motivation for learning. Inquiry learning strategy engages students on active learning of chemistry which was evident in their improved achievement (Dushimimana & Mugabo, 2022). It also develops students' inquiry skills which is a key aspect of lifelong learning. Considering the key role of inquiry in the 21st century education, Nigeria as a developing country has not been left behind in using inquiry-based teaching method as well as ensuring gender equality in all aspects of the teaching and learning process. The Theoretical Framework is anchored on Piaget's theory of constructivism.

Constructivism according to Piaget (1976) is the learning theory that serves as the foundation for the inquiry-based teaching approach. The dissatisfaction with behaviorism's didactic teaching approaches gave rise to this theory. In contrast to didactic teaching approaches, students in constructivism learning environments create and co-create their knowledge through an interactive process of inquiry, debate, sharing, and reflection. Instead of being viewed as passive recipients of knowledge from the teacher. When students make connections between what they already know and what they are learning, it fosters a deep comprehension of the material. "To understand is to discover, or reconstruct by rediscovery, and such conditions must come through constant inquiry. According to Piaget, if in future individuals are to be productive, there is need to inquire about the present, past, and future. Instead of being spoon-fed knowledge passively, constructivism learning empowers students to take charge of their education through active engagement with the teacher for feedback with gender curiosity. As a result, regardless of gender, chemistry teachers should look for a teaching strategy that may inspire and pique students' attention like inquiry based learning (Maris, 2019).

Researchers have seen throughout the years that success in Chemistry and related fields is influenced by gender (Akumah, 2013). Orefor (2016) went so far as to emphasize that women belong in the humanities and arts, while men belong in science, technology, and associated fields. According to this theory, girls tend to demonstrate a greater predisposition toward the arts and humanities, whereas boys seem to have a naturally favorable attitude toward scientific and technical topics. The issue is made worse by the fact that, according to Onah (2022), the majority of science teachers view science disciplines like chemistry and physics as having a masculine bent, which discourages women from pursuing these fields in favor of biology, agricultural science, and home economics. Other researches (Orefor, 2016; Nwankwo & Okoye, 2015) believed that gender had no impact on how well pupils performed in the sciences. Girls who get all of these and associated therapies develop a fear of science and science-related courses, which will undoubtedly have an impact on their final career choice and level of success. There is a need to try such an innovative strategy as the inquiry based teaching strategy to see what effect it will have on achievement of male and female students in the sciences, especially Chemistry. There is a lack of consensus regarding the issue of gender preference in science. More importantly, it is important to capture the interest of/bias girls and subsequently improve their achievement in chemistry and other science-related subjects.

In view of the problems of the study, the following specific purposes were raised to guide the study:

1. To determine the difference between the mean achievement scores of students taught stereochemistry with inquiry based teaching strategy and those taught using lecture method of teaching.
2. To determine the difference between the mean achievement scores of male and female students taught stereochemistry with inquiry based teaching strategy.
3. Interaction effect of teaching strategies and gender on students' achievement in stereochemistry.

In lieu of the purpose of the study, the following research questions were developed to guide the study

1. What is the difference in the mean achievement scores of chemistry students taught stereochemistry with inquiry based teaching strategy and those taught using lecture method of teaching?
2. What is the difference in the mean achievement scores of male and female students' taught stereochemistry with inquiry based teaching strategy?

The following research hypotheses were formulated for the study; which were tested at 0.05 level of significance

1. There is significant difference in the mean achievement scores of chemistry students taught stereochemistry with inquiry based teaching strategy and those taught using lecture method of teaching.
2. There is significant difference in the mean achievement score of male and female students taught stereochemistry with inquiry based teaching strategy.
3. There is significant interaction effect of gender and teaching strategies on students mean achievement scores in chemistry concept of stereochemistry.

Method

A pretest-posttest non-equivalent control groups design was used for the study. The primary reason for this is that participants in the control and experimental groups were not assigned at random. Classes in secondary schools are structured groupings, and the administration does not permit the disassembly and reconstruction of classes for study (Nworgu, 2018). The population of the study consisted of 4, 532 SS 2 Chemistry students in all the 33 public secondary schools in Enugu Education Zone. 96 SS II chemistry students (52 females and 44 males) drawn from two coeducational secondary schools in Enugu North Local Government Area were selected for the study using a purposive sample technique. Firstly the selection of Enugu North Local Government Area using a basic random sample approaches. Secondly the two coeducational schools in the local government area were chosen using purposive sampling. The selection process was based on the presence of well-equipped chemistry laboratories and qualified teaching chemistry instructors in those schools and gender integration. Next, the schools were assigned to experimental and control treatments using a simple random sample procedure (precisely balloting of lucky dip). Intact classes were used in the sampled schools so as not to disrupt the normal school activities. The technique was used so as to provide classes where boys and girls work together under the same classroom environment. Four weeks were used for the experiment. Each week had two periods (double periods each) of 40 minutes per period. The control group was taught using the lecture method which involves content-rich activities such as demonstrations, lecture, experiments and quantitative problem-solving which does not involve the students in concept mapping strategy and processes. For the experimental class, the same set of activities for the control group was carried out for both double periods; but in addition to discussing and writing schematic notations and chemical equation of the concept, students were engaged in a group of 5 students according to teacher's description. Each group was assigned a task within the context of the topic to carry out. The feedback of students' in the group was reported back to the teacher on a regular interval for corrections and further directives on what to do next. This formed the strategy employed in the inquiry based learning. The Chemistry Achievement Test (CAT), was the instrument utilized to gather the data. There were 25 multiple-choice items with four alternatives (prep-50) in the questions from 2017 to 2023. Three experts validated the instruments' face and content using table of specification provided, and Kuder Richardson 20 (KR-20) was used to verify the instruments' reliability. The results showed a coefficient of 0.84. The device is dependable and appropriate for data collecting, as evidenced by its excellent dependability index (Idoko, 2014). Students were given the test as a pretest and a posttest, respectively, before and after the treatment. The researcher graded the examination in order to prevent bias. The mean and standard deviation (SD) were used to answer the research questions, and analysis of covariance (ANCOVA) using SPSS version 24 was used to test the hypotheses.

Procedure/ Authorization

Data was gathered following official authorization from relevant authorities like school principal through the classroom teacher and laboratory assistant. A consistent set lesson plan as tools and guidelines were provided to research assistants and respondents for completing research instruments. Additionally, research assistants underwent thorough training. All data collecting sessions were conducted under identical class settings to reduce disparities and potential mistakes. The research instrument was distributed to students during a single class session, with a designated 30-minute time frame for completion, although most students finished within approximately 25 minutes.

Results

Research Question 1:

What is the difference in the mean achievement scores of chemistry students taught stereochemistry with inquiry based teaching strategy and those taught using lecture method of teaching?

Answer to Research question 1 is presented in Table 1

Table 1: **Mean and Standard deviation of achievement scores of chemistry students taught stereochemistry with inquiry based teaching strategy and those taught using lecture method of teaching.**

Teaching Strategy	**Pretest**			**Posttest**			
	N	Mean	SD	N	Mean	SD	Mean Gain
Inquiry Based Learning	48	24.17	12.49	48	67.00	12.25	42.83
Lecture method	48	25.67	11.16	48	58.29	17.10	32.62

Table 1 shows the pretest and posttest mean achievement scores of chemistry students taught stereochemistry with inquiry based teaching strategy were 24.17 and 67.00 while the gain in mean score was 42.83. Their counterpart taught using the lecture method had 25.67, 58.29 and 32.62 as pre-test, post-test and gain in mean scores respectively. This shows a 10.21 difference in gain in mean scores between the two groups in favor of the students taught with inquiry based learning strategy. The result also shows a remarkable difference in mean gain scores between students taught chemistry using stereochemistry with inquiry based teaching strategy than their counterparts in lecture method.

Hypothesis 1: There is no significant difference in the mean achievement scores of chemistry students taught stereochemistry with inquiry based teaching strategy and those taught using lecture method of teaching.

Table 2: Summary of Analysis of Covariance of effect of inquiry based teaching strategy on students' achievement in chemistry by Treatment and Gender

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2552.683[a]	4	638.171	2.896	.026	.113
Intercept	54510.481	1	54510.481	247.364	.000	.731
Pretest	698.426	1	698.426	3.169	.078	.034
Strategy	1697.698	1	1697.698	7.704	.007 *	.078

Gender	3.103	1	3.103	.014	.906	.000
Strategy * Gender	13.543	1	13.543	.061	.805	.001
Error	20053.276	91	220.366			
Total	399358.000	96				
Corrected Total	22605.958	95				

a. R Squared = .113 (Adjusted R Squared = .074)

Table 2 shows that at .05 level of significance, there was a significant main effect of the teaching strategy on students' academic achievement in chemistry concept of stereochemistry, *F (1, 91) = 7.704, P (.007) <.05.* Therefore, the Research hypothesis was confirmed and accepted. Thus, there is significant difference in mean achievement scores of students taught Chemistry concept of stereochemistry with inquiry based teaching strategy and those taught using lecture method. In favour of the experimental group (Inquiry based learning strategy)

Research Question 2: What is the difference in the mean achievement scores of male and female students' taught stereochemistry with inquiry based teaching strategy?
Answer to Research question 2 is presented in Table 3

Table 3: **Mean and Standard deviation of achievement scores of chemistry students taught stereochemistry with inquiry based teaching strategy**

Gender	Pretest			Posttest			
	N	Mean	SD	N	Mean	SD	Mean Gain
Male	29	26.48	14.24	29	67.38	11.72	40.90
Female	19	20.63	8.35	19	66.42	13.31	45.79

Table 3 shows the pretest and posttest mean achievement scores of male students (26.48 and 67.38) and their female counterpart (20.63 and 66.42) taught stereochemistry with inquiry based teaching strategy. The gain in mean score for male students was 40.90 while that of the female counterpart was 45.79. This indicates a mean difference of 4.89 in favor of the female students.

Hypothesis 2: There is no significant difference in the mean achievement score of male and female students taught stereochemistry with inquiry based teaching strategy.

Table 2 shows that at .05 level of significance, there was no significant influence of gender on the effect of teaching strategy on students' academic achievement in chemistry concept of chemical bonding, *F (1,91) =.014* P (.906) > .05. Therefore, the research hypothesis was rejected. Thus, gender has no significant influence on the academic achievement of students in Chemistry concept of stereochemistry.

Hypothesis 3: There is no significant interaction effect of gender and teaching strategies on students mean achievement scores in chemistry concept of stereochemistry.

Table 2 further revealed that at .05 level of significance, there was no significant interaction effect of gender and the teaching strategy on students' academic achievement in chemistry, *F (1, 91) = .061, P (.805) >.05.* Therefore, the research hypothesis was rejected. Thus, there is no significant interaction effect of gender and the teaching strategy of inquiry based learning on students' academic achievement in chemistry.

Discussion of the Findings

Firstly, the study revealed that there is significant difference in the achievement scores of the chemistry students taught stereochemistry with inquiry based learning strategy and those taught using a lecture method; in favor of students' in Inquiry teaching and learning strategy. The finding of the study is in consonance with Dushimimana and Mugabo, (2022) who observed that inquiry based teaching approach had a significant effect on students' performance in the selected Chemistry concepts. It was also discovered that inquiry method was more effective than the lecture method of teaching science in terms of students' overall performance in Chemistry concepts and other science related subjects. The finding was in agreement with Piaget (1976), who demonstrated the efficacy of students' active participation in lessons through construction of their knowledge. The study's findings revealed that there is no significant difference in the mean achievement scores of male and female students taught Chemistry concept of stereochemistry using inquiry based learning strategy among Senior Secondary School students Chemistry 2 in Enugu Education Zone of Enugu State. The finding of the study is in agreement with Onah (2022), Onah and Achufusi (2022), who noted that gender, is not factor with teaching approach in physics. Meanwhile the find does not agree with Ezeugo and Agwagah (2018) who revealed that the male students taught with inquiry based learning performed significantly better than their female counterparts taught with concept mapping. The study also showed that there is no discernible relationship between gender and instructional strategy and students' academic achievement scores in chemistry. This finding concurred with Onah (2022), which found no evidence of a significant interaction between gender and instructional strategy on students' physics conceptual understanding of waves. Onah and Nnadi (2022), on the other hand, observed a noteworthy interaction on students' academic progress in current electricity between gender and instructional treatment. It is clear that the scientific community cannot agree on how gender and instructional practices interact to affect students' conceptual grasp of science, particularly physics ideas. There is therefore a great need to embark on more studies in order to shed further light on this issue.

Conclusion/ Recommendations

Students' academic progress in stereochemistry is increased when the inquiry based teaching approach is used in instruction. This is because students' active involvement in constructing their knowledge through guided inquiry helped them to grasp the concept of stereochemistry and as such outperformed those who were taught the identical concept through lecture in terms of posttest results. Nonetheless, the results indicated that there is no discernible gender gap in students' academic achievement levels. Based on the findings of the study, the following recommendations were made:

1) The primary goal of teacher educators in universities and colleges of education should be to provide chemistry instructors with the knowledge and abilities necessary to implement the inquiry based teaching technique in secondary school stereochemistry.
2) The Federal Ministry of Education through seminar and workshop should encourage chemistry teachers to use inquiry based teaching as a teaching strategy as it improves students' achievement and not a gender biased strategy.
3) The curriculum of teacher-training programs should include a course on the inquiry based teaching strategy, through seminars, workshops, and other opportunities for working teachers to get refresher training on the method.
4) Curriculum should be reviewed by curriculum planners to reflect the strategy of inquiry based learning while textbook authors should be encouraged to incorporate the strategy in Chemistry textbooks to foster more achievement and gender equality.

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DIFFICULT CHEMISTRY CONCEPTS AS PERCEIVED BY STUDENTS AND TEACHERS OF SENIOR SECONDARY SCHOOLS IN AGBANI EDUCATION ZONE OF ENUGU STATE

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Abstract

The accepted general notion that chemistry is abstract in nature as it is presented via mathematical formulars, structures and arrows, goes to a long extent in being perceived difficult by the students, which in turn hinders their academic achievement and interest in the subject. Hence, the study investigated difficult concepts in chemistry as perceived by students and teachers in senior secondary schools in Agbani Education Zone of Enugu State. Two research questions guided the study. The study adopted descriptive survey design. The population for the study comprised 1462 senior secondary school three (SS3) chemistry students and 45 chemistry teachers in public secondary schools within Agbani Education Zone. A sample size of 359 (314 students and 45 teachers) was used for the study. The instrument for data collection was a structured questionnaire titled Difficult Chemistry Concepts Questionnaire (DCCQ), which was designed by the researcher. The instrument was divided into two sections namely: A and B. Sections A was based on the respondents' biodata while B consisted 46-item statements structured to elicit information from the respondents. The instrument was validated by three experts. In order to determine reliability of the instrument, the researcher administered 30 copies of the questionnaire on 28 SS3 chemistry students and 2 teachers in two schools in Enugu Education Zone to determine the overall reliability index of the instrument. Cronbach alpha reliability coefficient formula was used to estimate the reliability of the instrument, and an overall reliability coefficient of .75 was established. The data were collected by the researcher with the help of two research assistants. The collected data were analyzed using mean scores and standard deviation. The decision rule for interpreting the results was based on the values of the calculated means. Item responses on each of the research questions were considered high and difficult when the mean is 2.50 and above, and low and not difficult when less than 2.50. The results of the analysis revealed that the chemistry concepts in senior secondary school that teachers and students perceived as difficult are: chemical combination, mass volume relationship (stoichiometry), acid, base reaction, oxygen and its compounds, among others. The study also revealed that there was a significant difference between male and female chemistry students as well as teachers in their mean difficulty in some concepts. Based on the findings of the study, it was recommended that: teachers and students should devote greater attention to the teaching and learning of these difficult concepts, and workshops *and seminar should be organized for chemistry teachers to train them on how to effectively teach the identified areas where students struggle.*

Key Words: Chemistry Concepts, Difficult Chemistry Concepts, Perception

Introduction

Education is an instrument "par excellence" for effective national development. The development of any nation depends largely on the level of education attained by her citizens especially in the area of science and technology. It is highly rated as the most important instrument of change since any definite change in the intellectual and social outlook of the people must be preceded by an educational revolution. In cognizance with the importance of science and technology in national development, science subjects-Biology, Physics and Chemistry are taught in secondary schools to prepare a base for any science and technological development (Ababio, 2013). This according to Idoko (2014), is important because the knowledge of science in general helps man to understand himself, his environment and how his environment influences him.

Therefore, science according to Idoko (2014) is the application of man's acquired knowledge to influence and manipulate his environment to achieve better living condition for himself. In another report, Mbajiorgu (2018) stated that science is the study of natural occurrence or way of making sense of the natural physical world. Mbajiorgu further revealed that there cannot be any meaningful development without science. This is in agreement with the notion of Nwachukwu (2015) which reported that the development of the nation depends on the level of scientific teaching and knowledge received by individuals.

From the above explanations, science in a nutshell can be seen as a field of study which involves a systematic process of carefully investigating and obtaining knowledge about nature and its phenomena. This knowledge when fully acquired is fit to develop scientifically literate individuals with high competence for rational thought and action, which by implication will bring about national development. Moreso, this scientific knowledge is unavoidably related to the classroom setting. Hence, most learning approaches are largely dependent on technological competence and skills which are products of scientific knowledge. This implies that scientific knowledge can be acquired through effective teaching and learning of science concepts. Thus, science education is vital in inculcating scientific knowledge to the desired learners.

According to Cobern (2017), science education is the application of educational (learning) theories especially those based on the philosophical, sociological and psychological perspectives in the endless search for knowledge, resulting in the development of the cognitive, affective and psychomotor domains through some systematic processes involving careful observation, deduction and testing by empirical means. Cobern opined that for the purpose of teaching, science education is the process whereby persons (teachers inclusive) are prepared or equipped with knowledge and skills to help ensure the effective dissemination and inculcation of scientific concepts, culture and thinking process and activities through general accepted pedagogical strategies and theories. Science education is thus more than the presentation or acquisition of scientific facts and skill. Science education includes the development of new ways of thinking, reacting and behaving--a development that reveals itself in increased skills, knowledge and thinking capacities to tackle problems of life. It is the field of science that is concerned with sharing of science contents, some social sciences, and the process of teaching science pedagogy in order to provide expectations for the development of understanding part of the scientific community.

However, science as a discipline is broadly studied in three major subjects; Biology, Physics and Chemistry (Aniodoh, 2019). Aniodoh further stated that the concept of chemistry and chemical activities in the environment has helped to expose one's mind to the importance of chemistry to the society. Hence, the relevance of chemistry as a requirement for technological advancement of a nation cannot be looked down upon. The classification of any nation into developed, developing and under developed could be measured accurately by the number of chemists, physicists, engineers, pharmacists, doctors, agriculturalists and science educators the nation could produce. Chemistry is most commonly regarded as the central science or the mother of all Science owing to its confluence and influence (Ahiakwo, 2017). Chemistry as a physical science is that branch of science which deals with how substances are made, how they combine with each other under controlled environmental conditions, such as temperature and pressure, and how the subject can lay the necessary foundation for technological advancement Magbo, (2018). Chemistry is a science subject that deals with the properties, composition and structure of substances, the transformation they undergo and the energy that is released or absorbed during these processes (Alan, 2019).

Through the learning of chemistry, it is possible to acquire knowledge, skills and understanding in engineering, medicine and other related scientific and technological fields. According to Patrick (2020), using chemistry, pharmaceutical products were discovered which have contributed to improvement in life expectancy and quality of life of many patients. It has increased food production through the use of fertilizers and pesticides, and also increased developed plastics and other materials that are used in almost every facet of our lives.

Chemistry education plays a crucial role in developing students' scientific literacy and in preparing them for future careers in science-related fields.

The objectives of chemistry education according to the revised edition of the Senior Secondary School Chemistry Curriculum (NERDC, 2017), is expected among other things to enable students to:

i. Develop interest in the subject of chemistry.
ii. Acquire basic theoretical and practical knowledge and skills.
iii. Develop interest in science, technology and mathematics
iv. Acquire basic STM knowledge and skills

v. Develop reasonable level of competence in ICT applications that will engender entrepreneurial skills.
vi. Apply skills to meet societal needs of creating employment and wealth.
vii. Be positioned to take advantage of the numerous career opportunities offered by chemistry.
viii. Be adequately prepared for further studies in chemistry.

The above objectives are quite good and it is expected that when chemistry teaching is geared towards the attainment of the objectives, the students' achievement will be high. If the objectives are achieved, the chemistry students will not only be highly knowledgeable in chemistry, but will also acquire the necessary skills and competencies that will translate to high achievement in the subject in external examinations. The knowledge of chemistry provides important understanding of our world and how it works. It is an extremely practical science and its' knowledge and principles help in our daily lives, especially in the improvement of health care, conservation of natural resources, protection of the environment and provision of our everyday needs for food, clothing and shelter.

Despite the numerous important applications of chemistry to life, students encounter difficulties learning the subject because of the abstract nature of the subject, (Kousathana, 2019). The students offering chemistry are faced with various difficult concepts in the subject matter. The failure of senior secondary school students in chemistry over the years has been of great concern to scientific researchers, West African Examination Council chemistry results has consistently for two years recorded low grades for chemistry, for instance, far below average level was recorded in 2017 and 2018 respectively. Out of 454,28 that sat for chemistry WAEC exam in 2017 only 45.78% credited chemistry and in 2018 out 439,622 that wrote the exam only 45.46% credited chemistry (WAEC Chief Examiner, 2017 and 2018). It shows that students' performance on the average were below fifty percent from 2017- 2018 which was not too good. There has been an outcry by the students each year when WAEC releases their annual results, as a result of students' poor achievement especially in the Science subjects (Salami, Mohammed, and Ogunlade; 2019).

Candidates' achievement at the Senior School Certificate Examination (SSCE) conducted by WAEC has consistently remained poor with Chemistry having one of the worst and poorest results over the years (Ibe & Maduabam, 2019). For example, a look at the West African Examinations Council (WAEC) results in Chemistry from 2010 to 2014 shows that in 2010, out of 105,453 that sat for Chemistry in all the secondary schools in Enugu State only 26,680 credited Chemistry, in 2011, out of 107,781 candidates that sat for chemistry WAEC Examination, only 40, 506 credited the subject, in 2012, out 115, 549 that sat for the examination, only 35,095 candidates credited chemistry subject, and in 2013, out of 91,781 that wrote the exam, only 28,852 credited chemistry, also in 2014, out of 126,401 candidates that sat for the examination, 26,031 credited chemistry subject.

This means that only about one in four students can use Chemistry as one of the subjects that would qualify them for university admission. (Ibe & Maduabam, 2019).Yet, chemistry is a prerequisite to all courses in medicine and related field, all engineering courses, pharmacy, and many others that are considered prestigious by the society; this means that there will be a low number of admissions. WAEC annual report by Chief Examiners 2015 and 2016 also noted poor academic achievement in Chemistry which manifested in constant poor grades and repetition of classes. Thus, one tends to question why the general unsatisfactory academic achievement in Chemistry among the secondary school students. These poor achievements in Chemistry have made some researchers to study the problem with the hope of finding the causes and possible solutions.

Student's poor achievement in senior secondary school chemistry is as a result of the broadness and difficult concepts in chemistry. Other causes could also include; difficult chemistry concepts (Agogo, 2020), and the abstract nature of chemistry concepts (Samba & Eriba 2021). Concept is defined as a perceived regularity in objects or events or a record of events designed to be labeled. Examples are kinetic energy, thermodynamics, and so on.

Difficult concept is the extent to which a concept or topic can be comprehended by a learner. The spectrum stretches from least difficult where the student very readily progresses in the concept from rote to meaningful learning (Novak, & Grove, 2017) to the polar end of most difficult where the learner encounters challenges from meaningfully learning from the concept. Grove and Novak have implied it to mean the easiness or difficulty in attaining a concept. According to Erin (2020), Dealing with unobservable chemistry concepts can be challenging, as these concepts are not directly observable through our senses. Dealing with unobservable chemistry concepts requires creativity, rigorous reasoning, and a combination of experimental and theoretical approaches. Understanding chemistry indeed requires critical thinking skills. Chemistry is a complex scientific discipline that deals with the composition, properties, and reactions of matter. To grasp the concepts in chemistry, one must engage in critical thinking at various levels like, problem solving, conceptual understanding, analyzing data, and creativity, predicting outcomes, experimental design, problem identification, evaluation and reflection.

Chemistry is best understood and practiced by writing notes and formulas using a pen and paper.

Moreover, breaking down complex concepts, consistent practice, seeking help from teachers or peers, and using study aids can all aid students' understanding of difficult chemistry concepts (Erin, 2020). Omiko, (2017) in reaction to this opined that a concept is considered difficult if an academically average chemistry student performs poorly in it after evaluation, even when the teacher has put in his best during instructional delivery.

Individual's perception of a given concept depends on the cognitive ability and determines the level of understanding of the concept. Consequently, the concept of easiness or difficulty as perceived by any individual is dynamic, relative and subjective. This explains why a difficult concept to a particular student may be easy to another in the same class even under the same condition and can vary from person to person due to individual differences in cognitive abilities, learning styles and motivation. And the difficulty of a concept is subjective and depends on how a person perceived and interpret it.

Perception is the organization, identification and interpretation of sensory information in order to represent and understand the presented information (Pormerantz & James, 2019). It is important to understand student perceptions of how they perceive teachers' questions and answer questions in class. Those perceptions affect students' willingness to participate actively in question and answers sessions (Cole, 2017).

Perception refers to the process of interpreting and making sense of sensory information from our environment. It involves the way we perceive, understand, and interpret stimuli such as sights, sounds, tastes, smells, and touch. Perception is influenced by our previous experiences, cultural background, beliefs, and expectations, and it plays a crucial role in shaping our understanding of the world and our interactions with it (Drew, 2023).

Perception of difficult concepts in secondary school chemistry is a common issue that many students face. There are several reasons why students may find certain concepts in chemistry challenging to understand. One of the main reasons for the perception of difficult concepts in secondary school chemistry is the abstract nature of the subject. Chemistry deals with the study of matter, its properties, and how it interacts with other substances. Many of the concepts in chemistry are not tangible and require students to think in abstract terms. This can be challenging for students who are more accustomed to concrete, hands-on learning experiences (Smith, 2018).

Another reason for the perception of difficult concepts in secondary school chemistry is the complex terminology and symbols used in the subject. Chemistry has its own language, with a wide range of terms and symbols that students need to learn and understand. This can be overwhelming for students, especially those who struggle with memorization or have difficulty with language skills (Brown, & Jones, 2019). Additionally, the mathematical nature of chemistry can also contribute to the perception of difficult concepts. Chemistry involves a significant number of calculations and problem-solving, which can be challenging for students who are not comfortable with math. Understanding the mathematical relationships in chemistry requires a strong foundation in algebra and other mathematical concepts, which some students may lack (Johnson, 2020).The students' perceptions in chemistry can vary greatly. Some students may find chemistry fascinating and engaged in learning about the composition, properties, and reactions of different substances (Park and Roehrig, 2021). They may appreciate the practical applications of chemistry in everyday life, such as understanding the behavior of chemicals in food, medicine, or the environment.

On the other hand, some students may perceive chemistry as challenging and intimidating. They may struggle with understanding complex concepts, equations, and formulas. The abstract nature of chemistry, with its emphasis on atoms, molecules, and chemical reactions, can be difficult for some students to grasp. Additionally, some students may feel overwhelmed by the amount of memorization required in chemistry, as they have to learn the names, symbols, and properties of numerous elements and compounds. They may also find it challenging to apply theoretical knowledge to practical experiments and problem-solving tasks.

Overall, students' perceptions in chemistry can be influenced by their prior knowledge, learning style, and interest in the subject. Teachers' teaching methods, resources, and support can also play a significant role in shaping students' perceptions and attitudes towards chemistry.

To address students' difficulties, teachers can use various teaching strategies, such as using visual aids, providing clear explanations and examples, interactive activities, and offering extra practice and support. Breaking down complex concepts into simpler parts and providing real-world applications can also help students understand and relate to difficult chemistry concepts.

Gender differences in perception of difficult concepts. Studies have shown that there may be gender differences in how difficult concepts in chemistry are perceived by students. For example, a study by (Smith, Johnson., & Brown, 2018) found that male students were more likely to perceive certain concepts in chemistry as difficult compared to female students. This may be due to societal stereotypes and expectations that suggest that males are more adept at science and math subjects, while females are better suited for subjects in the humanities.

Furthermore, female students may be more likely to internalize feelings of inadequacy when faced with difficult concepts in chemistry. This can lead to a lack of confidence in their abilities and a reluctance to seek help or ask questions in class. In contrast, male students may be more likely to exhibit overconfidence in their abilities, which can also hinder their learning and understanding of difficult concepts. Gender as a factor responsible for students' perception of some concepts in chemistry. There are different levels of difficult concepts experienced by chemistry students and these concepts perceived difficult are experienced by both boys and girls. Gender stereotyping also influence the class room interaction patterns of students and teachers. Gender is a major factor that influences career choice and subject interest of students. It is stated that more difficult works are usually reserved for males while the females are considered feminine in a natural setting. Thus, in school males are likely to take difficult subjects areas like chemistry while the females take to career that will not conflict with marriage chances, marriage responsibilities and motherhood (Okeke, 2019). The female students show higher anxiety towards the learning of chemistry in secondary schools than the male students (Jegede, 2017).

Therefore, gender can indeed be a factor that influences students' perception of difficulty in learning chemistry concepts. It's important to acknowledge that gender stereotypes and societal expectation can impact students' self-perception, motivation and engagement in chemistry as a subject. In other words, knowledge is memorized but it is meaningless and does not translate into thought. This problem could be solved through appropriate teaching methods employed by the teacher.

Teachers' perceptions in chemistry vary greatly depend on their individual experiences, knowledge, and teaching styles. Some teachers may view chemistry as a challenging subject that requires a strong understanding of complex concepts and equations (Park & Roehrig, 2021). They may believe that students need to be highly analytical and detail-oriented in order to succeed in chemistry. Other teachers have a more positive perception of chemistry, seeing it as an exciting and engaging subject that allows students to explore the world of atoms, molecules, and reactions. They emphasize the practical applications of chemistry in everyday life, such as understanding how chemicals interact and how they can be used to solve real-world problems.

Some teachers view chemistry as a foundational science that lays the groundwork for further scientific study. They see it as a subject that helps students develop critical thinking and problem-solving skills, as well as fostering a curiosity about the natural world (Subahan & Ahamad, 2017).

However, there are teachers who struggle with teaching chemistry, finding it difficult to make the subject accessible and engaging for their students. They have limited knowledge or confidence in the subject matter, which can impact their perception of chemistry as a whole.

Teachers' perception of difficult chemistry concepts and their lack of interest in the subject have been reported to be a factor responsible for teacher-student perception of difficulty in science. (Ajayi, 2017).Teachers' perceptions of chemistry can greatly influence their teaching approach, the resources they use, and the level of enthusiasm they bring to the classroom. When encountering difficult concepts in chemistry, there are several effective approaches that are suitable for teaching difficult concepts in chemistry. One of the approaches to overcoming concept difficulty in secondary school chemistry is to provide students with hands-on, interactive learning experiences. Research has shown that students learn best when they are actively engaged in the learning process (Smith & Jones, 2018). By conducting experiments, demonstrations, and simulations in the classroom, students can see the concepts they are learning about in action, which can help them better understand and retain the information. Another approach is to use visual aids and multimedia resources to help students visualize abstract concepts. Studies have shown that visual learning can be particularly effective for students who struggle with traditional textbook-based learning (Brown & White, 2019). Chemistry teachers can use videos, diagrams, and animations to help students see how molecules interact, how reactions occur, and how elements are arranged on the periodic table.

Additionally, providing students with opportunities for collaborative learning can help them overcome concept difficulty in chemistry. Working in groups allows students to discuss and debate ideas, ask questions, and receive feedback from their peers (Johnson, 2020). This can help students deepen their understanding of the material and develop critical thinking skills.

Furthermore, breaking down complex concepts into smaller, more manageable chunks can help students grasp difficult concepts in chemistry. Chemistry teachers can use scaffolding techniques to guide students through the learning process, providing them with the support they need to build their understanding step by step (Clark & Lewis, 2017). By breaking down complex concepts into smaller parts, students can focus on mastering one concept at a time before moving on to more advanced topics. By implementing these approaches, chemistry teachers can help students develop a deeper understanding of chemistry and build the skills they need to excel in the subject.

In Agbani education zone, the understanding of difficult chemistry concepts among students is a matter of concern. Many students struggle to grasp critical topics, resulting in poor academic achievements and a general lack of enthusiasm for the subject. Understanding the underlying reasons for these difficulties is essential for educators and policymakers to design effective interventions that improve the teaching and learning of chemistry in senior secondary schools; hence, the need for this study.

Statement of the Problem

Chemistry education plays a crucial role in developing students' scientific literacy and in preparing them for future careers in science-related fields. However, it has been observed that students in senior secondary schools within Agbani education zone encounter difficulties in understanding and mastering chemistry concepts. These difficulties may hinder their overall academic achievement, and interest in the subject. Furthermore, the perceptions of difficult chemistry concepts among students and teachers may vary, leading to discrepancies in instructional practices and assessment approaches.

The specific problems to be addressed in this research study include: Lack of specific understanding of the difficult concepts in chemistry, reasons why chemistry concepts are difficult to teach and learn in senior secondary schools and the approaches employed to solve the problems.

Addressing these issues will provide valuable insights into the difficulties faced in teaching and learning chemistry concepts in senior secondary schools within Agbani education zone. The concern of this study is therefore set to provide answers to the problems of the research which is posed in a question form: what are the difficult chemistry concepts as perceived by students and teachers in senior secondary schools in Agbani education zone of Enugu State.

Research Questions

The study was anchored on the following research questions:

1. What concepts in the senior secondary school chemistry do students and teachers perceived difficult to teach and learn?
2. What difference exists between male and female student's perceived difficult concepts in senior secondary school chemistry?

Method

A descriptive survey design was adopted for the study. A survey design, according to Nworgu (2015) is a design where peculiar characteristics of a known or identified population are studied through a sample, which is deemed to be representative of the population. Such study is only interested in describing certain variables in relation to the population. Ojo (2019) opined that survey is the best technique for obtaining the necessary data from a group in which the sample drawn from the population and their opinion will be used to generalize the opinion of the entire population. It is used in studies that involve finding individual opinions (Olaitan,2018). This design was considered appropriate for the study because it made use of questionnaire in obtaining the opinions of the respondents used in the study. Hence, the study sought the opinion of the students and teachers in Agbani Education Zone on their perception of difficult chemistry concepts in senior secondary schools. The study was conducted in Agbani Education Zone of Enugu State. Agbani Education Zone is one of the six Education Zones in Enugu State. It is made up of three Local Government Areas thus: Enugu South, Nkanu East and Nkanu West. There are 45 public secondary schools in Agbani Education Zone. Enugu South has a total of 14 public secondary schools, Nkanu East 19 and Nkanu West 12, this amounting to a total of 45 public secondary schools within the context of Agbani Education Zone. The population for the study consisted all the senior secondary school three (SS3) students who offered chemistry and all the chemistry teachers in the 45 public secondary schools within Agbani Education Zone. The population size was 1462 chemistry students and 45 chemistry teachers. A sample size of 359 (314 students and 45 teachers) was used for the study. To determine the sample size of students, Taro Yamane's formula was used and a sample of 314 students (132 male and 182 female) were drawn from the population of 1462. In addition, all the 45 chemistry teachers were used for the study. Therefore, 314 SS3 students and 45 chemistry teachers sum up to a total sample size of 359 respondents.

A 46- item structured questionnaire titled Difficult Chemistry Concept Questionnaire (DCCQ) was used as instrument for data collection, which was designed by the researcher in line with research questions that guided the study. The questionnaire was arranged in two parts, Section A, and Section B. Section A was concerned with the bio-data of the respondents, while section B consists of items raised to answer the research questions. The items of the DCCQ were structured to have four points' scales of: Very Difficult (VD), Difficult (D), Moderately Difficult (MD) and Not Difficult (ND).

Numerical values of 4, 3, 2 and 1 were given to the options respectively in each line of scale.

The Instrument was subjected to face and content validation. The instrument was validated by three experts, two from Science Education Department, and one from Mathematics and Computer who majors in Measurement and Evaluation, all from Faculty of Education, Enugu State University of Science and Technology, ESUT). The validators made some constructive comments which formed the basis for the modification of the items before using it. In order to determine reliability of the instrument, the researcher administered 30 copies of the questionnaire to 28 SS3 chemistry students and 2 teachers in two schools in Enugu Education Zone to determine the overall reliability index of the instrument. Cronbach alpha reliability coefficient formula was used to estimate the reliability of the instrument, and overall reliability coefficient of .75 was established. To distribute the instrument, the researcher visited the schools with two research assistants. At spot delivery method was used in data distribution, this was to ensure 100% return rate of the distributed instrument. The data were collected by the researcher with the help of two research assistants. The collected data were answered using mean scores and standard deviation. Therefore, the decision rule for interpreting the results was based on the values of the calculated means. Item responses on each of the research questions were considered high and difficult when the mean is 2.50 and above, and low and not difficult when less than 2.50.

Results

Research Question 1: What Concepts in the Senior Secondary School Chemistry do Students and Teachers Perceived Difficult in Agbani Education Zone?

Table 1: **Mean and Standard Deviation scores of Students and Teachers Perceived Difficult Concepts in Secondary School Chemistry.**

S/N	Difficult chemistry Concepts as Perceived by Teachers and Students	X	Std. Deviation	Decision
1	Particulate nature of matter	2.40	1.131	Not Difficult
2	Chemical combination	2.58	1.080	Difficult
3	Gas law	2.36	1.123	Not Difficult
4	Periodic table and periodicity	2.46	1.113	Not Difficult
5	Rates of chemical reaction	2.47	1.064	Not Difficult
6	Mass volume relationship (stoichiometry)	2.51	1.138	Difficult
7	Quantitative analysis	2.33	1.106	Not Difficult
8	Acid, base reactions	2.55	1.142	Difficult
9	Water and solution (solubility)	2.47	1.088	Not Difficult
10	Oxygen and its compounds	2.55	1.081	Difficult

11	Hydrogen and their compounds	2.65	1.156	Difficult
12	Sulphur and their compounds	2.36	1.094	Not Difficult
13	Nitrogen and their compounds	2.58	1.130	Difficult
14	Oxidation and reduction (redox reaction)	2.58	1.087	Difficult
15	Electrolysis	2.37	1.121	Not Difficult
16	Petroleum	2.42	1.113	Not Difficult
17	Metals and their compounds	2.60	1.104	Difficult
18	Carbon and their compounds	2.45	1.117	Not Difficult
19	Hydrocarbons	2.53	1.118	Difficult
20	Alkanols	2.45	1.053	Not Difficult
21	Alkanoic acid	1.65	.669	Not Difficult
22	Qualitative analysis	2.04	.863	Not Difficult
23	Giant molecules (sugar, starch and proteins)	2.26	1.032	Not Difficult
	Grand Mean	**2.41**	**1.074**	**Not Difficult**

The data in Table 1 above shows that 9 out of 23 concepts in senior secondary school chemistry concepts were perceived as difficult by teachers and students of senior secondary schools in Agbani Education Zone. The high mean scores of Chemical Combination 2.55, mass volume relationship (stoichiometry) 2.51, acid, base reaction 2.55, Oxygen and its compounds 2.55, Hydrogen and their compounds 2.65, Nitrogen and their compounds 2.58, Oxidation and reduction (redox reaction) 2.58, Metals and their compounds 2.60, and Hydrocarbons 2.53 were perceived difficult. While the mean scores of particulate natures of matter 2.40, Gas law 2.36, Periodic table and periodicity 2.46, Rates of chemical reaction 2.47, Quantitative analysis 2.33, Water and solution (solubility) 2.47, Sulphur and their compounds 2.36, Electrolysis 2.37, Petroleum 2.42, Carbon and their compounds 2.45, Alkanols 2.45, Alkanoic acid 1.65, Qualitative analysis 2.04, and Giant molecules (sugar, starch and protein) 2.26 have low mean scores and were considered not difficult. Generally, items in cluster 1 above have a grand mean score of 2.41 which is below the 2.50 mean benchmark of set for the study. This indicates that respondents are in disagreement that all items1-23 in Table 1 are difficult chemistry concepts perceived by chemistry teachers and students in Agbani Education Zone of Enugu State.

Research Question 2: What Difference Exist Between Male and Female Students on Perceived Difficult Concepts in Secondary School Chemistry in Agbani Education Zone?

Table 2: Mean and Standard Deviation scores of Male and Female Students on Perceived Difficult Concepts in Secondary Schools chemistry.

		MALE			FEMALE		
S/N	**Difficult chemistry Concepts as Perceived by male and female Students**	**X**	**SD**	**Decision**	**X**	**SD**	**Decision**
24	Particulate nature of matter	2.45	1.142	ND	2.37	1.127	ND
25	Chemical combination	2.55	1.058	D	2.59	1.094	D
26	Gas law	2.33	1.130	ND	2.38	1.120	ND
27	Periodic table and periodicity	2.47	1.101	ND	2.46	1.122	ND
28	Rates of chemical reaction	2.48	1.073	ND	2.46	1.061	ND
29	Mass volume relationship (stoichiometry)	2.55	1.174	D	2.48	1.118	ND
30	Quantitative analysis	2.39	1.089	ND	2.30	1.117	ND
31	Acid, base reactions	2.55	1.148	D	2.56	1.141	D
32	Water and solution (solubility)	2.47	1.059	ND	2.48	1.106	ND
33	Oxygen and its compounds	2.58	1.042	D	2.54	1.106	D
34	Hydrogen and their compounds	2.65	1.152	D	2.64	1.160	D
35	Sulphur and their compounds	2.39	1.089	ND	2.34	1.099	ND
36	Nitrogen and their compounds	2.56	1.154	D	2.59	1.118	D
37	Oxidation and reduction (redox reaction)	2.56	1.086	D	2.60	1.090	D
38	Electrolysis	2.35	1.105	ND	2.38	1.132	ND
39	Petroleum	2.45	1.114	ND	2.40	1.114	ND
40	Metals and their compounds	2.61	1.123	D	2.59	1.095	D
41	Carbon and their compounds	2.47	1.115	ND	2.43	1.120	ND
42	Hydrocarbons	2.58	1.094	D	2.53	1.134	D
43	Alkanols	2.49	1.015	ND	2.43	1.076	ND
44	Alkanoic acid	1.70	.709	ND	1.62	.644	ND
45	Qualitative analysis	2.06	.880	ND	2.02	.854	ND
46	Giant molecules (sugar, starch and proteins)	2.58	.996	D	2.07	1.008	ND
	Grand Mean	**2.44**	**1.071**	**ND**	**2.40**	**1.076**	**ND**

The Table 2 above shows that male and female students of senior secondary schools in Agbani Education Zones differs in their mean scores on difficult chemistry concepts. Only the male students perceived mass volume relationship (stoichiometry) 2.55, and Giant molecules (sugar, starch and protein) 2.58, to be difficult while it was not difficult for the female student. Generally, items in cluster 2 above have a grand mean score of Male and Female respondents are 2.44 and 2.40 respectively which are below the 2.50 mean benchmark of set for the study. This however, indicates that the responses of male and female respondents show difference in the chemistry concept perceived difficult by the students.

Discussion of the Findings

The discussion is presented under the following captions:

Perception of Difficult Concepts in Secondary School Chemistry by Teachers and Students.

The findings of the study in Table 1 revealed that teachers and students perceived 9 out of 23 concepts in senior secondary school chemistry as difficult. The test for null hypothesis in Table 5 indicates that there was a significant difference between the mean scores of teachers and students. The findings are in line with the results of Musounda (2022), which revealed that most difficult concepts were mole concept, stoichiometry, electrolysis, organic chemistry and redox reaction. This means that students may not perform well in their final year examination if the sources of difficulties are not removed. The findings are also in agreement with Jonah (2021) which indicated that students and teachers perceived 15 out of 19 concepts difficult to comprehend in chemistry. This implies that there were significant differences in perception of mean difficulty between teachers and students on such concepts. This finding concurs with Inibehe (2018) who noted that students perceived particulate nature of matter, chemical bonding, periodic table, acid, bases and salts, oxidation reduction reaction, mass volume relationship, quantitative analysis, electrolysis and hydrocarbons as difficult concepts. The above noted is supported by the report of Fatima (2020) which revealed that concepts students perceived as difficult in chemistry exceed that of the concepts perceived not difficult.

The findings are also in agreement with Abdul-Kadir (2018) which revealed that students perceived 12 concepts 63% as difficult out of the 19 concepts in the questionnaire. In the same vein, the findings of the study are in agreement with the report of Peter (2017) which observed that the student in mass volume relationship, hydrogen reactivity series, ionic theory, hydrocarbon, alkanols and alkanoic perceived difficult to learn. Balancing chemical equations and performing stoichiometric calculations require strong mathematical skills and an understanding of mole concepts.

Perception of Difficult Concepts in Secondary School Chemistry by Male and Female Students

The finding of the study revealed that male and female students of senior secondary schools in Agbani Education Zones differs in their mean scores on perceived difficult chemistry concepts. Gender consideration in Table 2 revealed that only male students perceived 10 out of 23 concepts as difficult while female students perceived 8 out of 23 concepts as difficult to learn. The test for null hypothesis in table 6 was rejected indicating that there is significant difference between the mean scores of male and female students in favor of the female students because the male students perceived more concepts (mass volume relationship and giant molecules) difficult. The findings of the study are in agreement with the report of Peter (2017) which posited that there is level of concepts difficulty experienced by male and female students in the study of chemistry science subject especially chemistry. The findings are also in agreement with Oladejo, Ademola and Ayanwale (2023) which revealed that there is a slight difference in the perception of male and female students.

The findings of the study are in line with Inibehe (2018) who revealed that only male students perceived stoichiometry, water and solution, oxidation and reduction reaction, electrolysis, carbon and its compounds, as difficult concepts while only female students perceived sulphur and its compounds, and halogens and its compounds difficult to learn. The findings are also in agreement with Jonah (2021) which indicated that there are significant between male and female students in their mean difficulty in some concepts. The findings of the study however were in disagreement with the findings of Fatima (2020) which found out that gender difference has no influence on their perception of difficult concepts in chemistry. The finding of the study is in conformity with the finding of Adul-Kadir (2018) who revealed that the result based on gender showed that the male perceived 15 concepts in SSS3 chemistry concepts as difficult, while the female perceived 11 concepts as difficult; there was significant influence of gender on students' concepts perceived as difficult in the chemistry syllabus. The findings of the study were in disagreement with the findings of Peter (2017) which indicated that there is no significant difference between male and female chemistry students in their perception of difficult concepts in chemistry.

Conclusion

The purpose of the study was to identify difficult concepts in chemistry as perceived by teachers and students in senior secondary schools in Agbani Education Zone. The results of the analysis revealed that the chemistry concepts in the senior secondary school that teachers and students perceived as difficult are: chemical combination, mass volume relationship (stoichiometry), acid, base reaction, oxygen and its compounds, hydrogen and their compounds, nitrogen and their compounds, oxidation and reduction (redox reaction), metals and their compounds and hydrocarbons. The study also revealed that there was a significant difference between male and female students as well as teachers in their mean difficulty in some concepts.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Teachers and students should devote greater attention to the teaching and learning of these difficult concepts. The teacher should devise a means on how to make students understand the concepts identified to be difficult. Both male and female chemistry students should be encouraged to learn chemistry with greater emphasis on male students.
2. The areas of difficulties identified by students should be noted and the chemistry department with its team of teachers should devise means on how to make students understand the concepts identified to be difficult.

3. Workshops and seminar should be organized for chemistry teachers to train them on how to effectively teach the identified areas where students struggle.
4. Use a combination of data collection instrument such as questionnaires, interviews and classroom observations to triangulate data and reduce bias.

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THE NEED FOR ADOPTION OF RESPONSIVE CURRICULUM IN NIGERIAN SECONDARY SCHOOLS.

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Abstract

A responsive curriculum is a curriculum that is relevant to the current and anticipated needs, problems and aspirations of the learners. Unfortunately, the curriculum that is in use does not address the anticipated needs, problems and aspirations of the learners, or it is not responsive enough to meet the technological needs of the society. Therefore, a concerted effort and a total overhauling towards our education policy is imminent at this point in time. The present curriculum enthrones western culture in our land, thereby, undermining the culture and value of different states in this nation. Our educational system and value have been raped and murdered on the altar of modernization. The Nigeria education system is in trouble; and every day it continues to dwindle and deteriorate in essence, structure and purpose. The extent of damage that has been meted on our education is too alarming. The work revealed that in order to remedy the illness with Nigeria curriculum, there is need for the adoption of responsive curriculum development and employ this curriculum strictly in Nigerian education system. It showed that amongst other features, responsive curriculum should be: integrated and interdisciplinary, authentic, learner-centered and oriented to real life situations, utilizing materials from the learner's culture, assisting the learner to develop critical thinking ability. It also revealed that for the attainment of Nigeria's development through the instrumentality of curriculum, it is imperative that curriculum designers develop a responsive curriculum whose adoption in the Nigerian schools will develop valuable human capital that is needed for economic growth and human development. In view of the study, the researchers recommended that: curriculum experts should design a curriculum that is responsive to the current needs, aspirations and problems of the people, and in line with technological advancement, Government should motivate teachers through increase in salary and allowances so as to encourage them in putting in their best in harnessing the potentials of our future generation and teachers should prepare their teaching contents/objectives by effectively utilizing materials/ideas from learner's culture.

Key Words: Adoption, Responsive Curriculum, Technological needs

Introduction

The contents of teaching and learning subjects in the Nigerian Secondary Schools, which by implication equip the learner with the capability and potential to be useful to himself and the society are contained in a well-defined and simplified teaching/learning guide called the curriculum. The curriculum has the ability to shape the learner's cognitive development such that he becomes useful to himself, express an effective living, contributes his quota in the societal development and become mastery in problem-solving.

The contemporary curriculum in use in Nigerian secondary schools which is satisfactory and functional, is the thematic approach. The settlement at thematic approach after going through the different approaches to curriculum content selection is basically to reduce overloading of content, and allow for directives from government and requests from other stakeholders in education. This is gradually being implemented. However, the minimum number of subjects to be taken by each student at various levels is still unsettled as there are strong arguments for their reduction. For the organization of content, the practice the current curriculum over the years has favoured the spiral or concentric approach, which requires a good use of experience and information of learners' readiness in class. Giving the wide ability ranges in the large classes, and the deficiency in teacher supply in schools, using this strategy to obtain maximum benefit remains a big challenge in curriculum development and implementation.

In the case of content delivering however, the guided discovery approach remains the preferred option. The method and the use of all its appropriate strategies are recommended for the learner-centered and activity-oriented programmes developed for the school system. In this connection, the intended role of the teacher as a facilitator or moderator in a class that expects proper and effective interaction, is further challenged by the presence of large number of students. The use of modern techniques involving information and communication technology (ICT) gadgets, which could ameliorate the situation, poses a further challenge in curriculum development, given our environmental context and level of technological development. Evaluation is a major concern in curriculum development; however, the provision of evaluation guide in the national for curriculum content has remained an unsettled issue. We have moved from one extreme to another; and require settling in between the extremes. This is also a challenge in our contemporary curriculum. At the tertiary education level, minimum academic standards have been established for programmes in universities, polytechnics and colleges for quality assurance. However, regular accreditation has continued in these institutions with satisfactory results; and resolving the dearth of facilities for the implementation of their programmes is a major challenge to the regulatory bodies.

The term curriculum was derived from the Latin word "*Currere*" which means running a course. According to Akubuilo (2014), curriculum is a planned and organized set of formal educational and training intentions geared towards the acquisition of pre-specified competencies. Curriculum refers to the particular course or plan of study in a school, consisting of learning activities and assignments used to achieve course goals or standards. Curriculum is the skills, knowledge, understandings and dispositions. that students are to acquire through their instructional and extra class experiences. It refers to the lessons and academic contents taught in a school or in a specific course of program. Wikipedia (2013) views curriculum as a planned sequence of instruction, or student's experiences in terms of the educator's or schools' instructional goals. The curriculum broadly contains the different instructional objectives which the learners are unavoidably expected to grasped at the end of the lesson. It contains a well broken-down contents that ought to form the integral knowledge of performance of the said learners. This instructional objectives amongst others are properly itemized and organized based on the three educational domains of learning; cognitive, affective and psychomotor domains. These domains form the basis for formulating the instructional objectives in the teaching/learning process.

However, the curriculum that is in use does not address the anticipated needs, problems and aspirations of the learners, or it is not responsive enough to meet the technological needs of the society. Therefore, a concerted effort and a total overhauling towards our education policy is imminent at this point in time. The present curriculum enthrones western culture in our land, thereby, undermining the culture and value of different states in this nation. Our educational system and value have been raped and murdered on the altar of modernization. The Nigeria education system is in trouble; and every day it continues to dwindle and deteriorate in essence, structure and purpose. The extent of damage that has been meted on our education is too alarming, thereby militating against the attainment of the expected objectives of school curriculum.

In order to ensure the attainment of the intended instructional objectives of school subjects' curriculum, which is expected to bring about some positive changes in the learners, subjects' curriculum must be adequately and carefully designed toward being "Responsive" and likewise be effectively implemented.

Concept of Responsive Curriculum

Responsive curriculum is a curriculum that is relevant to the current and anticipated needs, problems and aspirations of the learners (Ema, 2019), Ema further stated that it is the curriculum that equips the learners for development in Information, Communication and Technology (ICT); local and global challenges of ensuring peace and resolving conflicts, devastating health problems and myriads of social, economic and political demands that stare individuals and societies frontally on daily basis. A responsive curriculum takes cognizance of vital changes and challenges in the environment and prepares the learner to meet them. Any curriculum that does not respond to the major waves of changes in the learners' environment, that is, equipping them with the competency skills of solving their current or future problems and that of the society is valueless. A responsive curriculum addresses the learners' background and recognizes their learning differences. According to Mkpa (2017), it tilts towards curriculum diversification and transformation of secondary school curricula, and offering instructions which are responsive to students' multi-ethnic and cultural heterogeneous setting.

Curriculum emanates from peoples' life and culture, therefore, a curriculum that takes into cognizance the cultural background of the learner and the societal need, fears and worries of the individuals and the society. It tackles the immediate need of the societies especially in the face of epidemic or natural disaster. Responsive curriculum fills the gap between the old knowledge and the new technology in order to meet up with the progressive and dynamic nature of the global technology. The goals and objectives which the society seeks to achieve are made possible through the aegis of curriculum as the instrument. Emereuwa (2014) opines that planners of an Ecurriculum in a society should know generally about the society's past and present life including its future life expectations. Thus, a responsive curriculum is inevitable to achieve such a landmark in the life of any society.

Since the world is ever advancing in the area of science, and as established earlier that the societal changing demands need be met, it then becomes important to know that the responsive curriculum in use should provide scientifically the ever-changing needs, problems and aspirations of the learners. Science being an important aspect of life cannot be overlooked when designing the curriculum. Therefore, the curriculum in use should be responsive enough to capture the scientific indices which are relevant in educating the prospective learners for effective living in the society, and for effective contribution of their quotas in societal development. In the same vein, the responsive curriculum should be able to address the learners' artistical life. For the society to have a balance, the curriculum should be detailed in arts and humanities. This is because, any curriculum that has not addressed the social, mental, psychological and well-being of the learners has not delivered enough in function. This goes further to explain that responsive curriculum plays a vital role in building the social traits of the citizens for effective living.

Features of Responsive Curriculum

In identifying the characteristics of responsive curriculum, another scholar, Abdal- Haqq (2016), itemized the following as the basic features of a responsive curriculum.

1. Being integrated and interdisciplinary.
2. Being authentic, learner- centered and oriented to real life situations.
3. Utilizing materials from the learner's culture.
4. Assisting the learner to develop critical thinking ability.
5. Incorporating co-operative learning and the development of self-esteem through the application and recognition of multiple intelligence facilities.
6. Requiring receptive school climate and recognition of the power of the hidden curriculum and
7. Supportive of appropriate staff development and pre-service preparation

Integration and Interdisciplinary: Life issues and problems are multifaceted. The transcend any one discipline or subject specialization. Related issues and problems need related treatment. For instance, some social problems may not be adequately addressed by an isolated social science discipline. Given the pervasiveness and enormity of some of these problems multidimensionally. This calls for integration and interdisciplinarity in curriculum development and instructions. Social studies for instance, presented in its integrated nature, can avail the learner of a web-like approach to social, economic, political and related problems. Therefore, for the curriculum to respond adequately to the needs and problems of the learners and society as a whole, it requires the ingredient of integration.

Orientation to Learner's Real Life: One key reason for educational reforms is the need to make learning relevant to real life's encounters of the learner. A culturally responsive curriculum draws materials from the learner's culture and experience to illustrate principles and concepts (Chion-Kenney, 2014). This engenders transfer of learning. Referent situations reflective of the learner's environment are created in the classroom if the curriculum is to take cognizance of the environment of the learner in its offerings. These referent situations constitute the issues of the learner's environment reflected in the curriculum and the classroom. Making the curriculum relevant to the learner's environment is very crucial to positive learning.

Utilizing Materials/Ideas from Learner's Culture: As observed by Thomas (2017), developing countries have begun to realize that their own traditional structures, ways of communication, values and beliefs, have pivotal roles in the future of the society. He observed that the cultural heritage of most developing countries had suffered some form of neglect, attributable to their drive to modernize their educational systems, looking mostly to the west which has a different cultural environment. By so doing, he observed, these governments hope that more up-to--methods of teaching and learning will give them a competitive edge and eventually lead to a greater economic success.

Development of Critical Thinking Ability: The enormity of social, economic and political problems confronted by societies daily makes it almost imperative that learners develop skills if critical thinking and analysis. It is a problem-solving device that has become very crucial in today's world. So, a responsive curriculum contains contents and methods that can help the learner develop problem-solving capacities.

Co-Operative Learning and Utilization of Multiple Intelligence and Learning Styles: Co-operative learning is promised on the belief and evidence that shared responsibility and interaction can produce positive feelings towards tasks and others, generate better inter-group relations and result in better self-image and learning (Joyce & Weil, 2020). They observed that "a democratic society requires that we work together to understand each other's world and develop a shared perspective that will enable us to learn from each other and govern ourselves while preserving a pluralistic reality". Again, multiple intelligence facilities and learning styles are required for learners to respond properly to diverse demands from the social and physical environment. In learners' inter-group and inter-group relations, various learning styles are exhibited and should be accommodated.

Supportive Staff Development and Pre-Service Preparations: Global political, economic, social and technological changes have made it expedient to examine present staff development policies in the school system in the developing nations vis-a-vis these changes. For instance, what proportion of serving teachers are computer literate? Can source materials from the web or internet be used efficiently? Or can teachers do power point presentations? What programmes are in place to expose them to emerging technological and social demands of the time? These are some of the challenges that necessitate educational reforms that involve developing curricula that can respond to key societal demands. The teacher therefore must be versatile to be able to implement a responsive curriculum.

Issues in Developing Responsive Curriculum

Responsive curriculum is often associated with making curriculum reflective of the learner's culture both at the developmental and implementation stages. Notable among the issues to be considered in developing responsive curriculum include the following:

1. An understanding of the environment of the learner, the current and anticipated social-cultural, political, economic and technological circumstances, changes, needs and problems of the learners and society. An in-depth study of the learner's cultural environment is a necessary starting point in developing a responsive curriculum.
2. The selection or modification of educational objectives to reflect the current and future needs and problems of the society.
3. Selecting contents that are consistent with emergent and anticipated needs e.g. curriculum contents on Sex/AIDS education, peace and conflict resolution, ICT, population issues, economic survival and ethnic issues.
4. Identification of the strategies to be adopted for Implementation of the curriculum. This also involves creating an appropriate classroom atmosphere that takes into consideration learners’ different backgrounds, learning styles and educational interest.
5. Selection of relevant resources for the implementation of the responsive curriculum. The resources should be culturally relevant. What may engender learning in a particular environment, say Europe, may produce negative result in another environment, say an African environment.
6. The instructional materials used in Implementing responsive curriculum should overcome the subtle pitfalls that Chion-Kenney (2014) observed are found in some curriculum materials: fragmentation and isolation, invisibility, selectivity and imbalance, stereotyping, and language bias.

7. Evaluation of the processes and outcomes of learning: it's expected that he criteria of evaluation are adhered to in responsive curriculum evaluation.

To achieve a better education for everyone, curriculum planners and policy makers must adopt the principles of recognizing, complexity, diversity and need for action at all levels of education and in cooperation and synergy with promising trends in order to make education available and accessible to all. We should not narrow down our educational activities to the classroom only, so as not to continue producing ill-equipped graduates with little or no practical aspect of the education that can help them perform optimally when faced with the realities of life. Nigeria lacks internal mobility to improve her economic development. This internal mobility can be achieved through diversification of the curriculum in terms of expanding the present curriculum in use to include entrepreneurial education, ICT and all manner of science and technical skills needed by new work place organization. An all-embracing subject matter curriculum at all levels of our education will equip school graduates with the necessary skills to contribute to nation building. The overarching strategy is to improve access and quality of education and make it more relevant to productive activities, value-orientation, employment generation and wealth creation. This implies critical reappraisal of the curriculum in use to produce answers to the prevailing problems (Ukwungwu, 2015). He went further to say that, "curriculum diversification can fill this gap created by inadequacy of the present curriculum.

The Role of the Teacher in Responsive Curriculum Implementation

In as much there's urgent need for the adoption of the above curriculum, the work of the teacher in curriculum implementation cannot be over emphasized. It is the teacher that executes these curriculum activities/curriculum actions/documents and so, the teacher and the curriculum move side by side. This implies that one cannot discuss elaborately on responsive curriculum without the mention of the teacher who is the curriculum implementer. As a curriculum implementer, it follows that the teacher is the one who brings the curriculum documents to limelight and to reality. Another name for the teacher is curriculum implementer. The teacher is one who translates the curriculum document into operating curriculum through a joint effort of hers/his, the learners and other interest groups as viewed by Mkpa (2017).

Stenhouse (2015) identifies the teachers as the key factors in curriculum implementation. Stenhouse submitted that curriculum implementation refers to how the planned curriculum is translated by the classroom teacher into syllabus, schemes of work and lessons to be delivered to the students. In order words, teachers are the key agents in the implementation process. This implies that the task of implementing the curriculum lies on the teacher. The teacher does not just implement the content as it is, rather he breaks the content into teachable units. Precisely what comes to the teacher is not the curriculum plan rather the syllabus which he breaks down to get the scheme of work, down to the unit of plan and finally to the lesson plan which is being used daily in his/her teaching.

Justification for the Adoption of Responsive Curriculum in Nigeria

Students learn better in their own culture and language and not in a borrowed culture. More so, any curriculum that undermines the background of the learner, goals and objectives of the society does not worth it. Culturally valued knowledge has to do with the inclusion of knowledge that is relevant to the student's life. More so, it is through education that development comes to a society. The more educated or learned a society is, the more developed she is. That Nigeria is among the developing nation of the world is because of little or no attention paid to responsive curriculum which resulted to gross illiteracy and production of half-baked graduates found in the country.

However, in order to remedy the illness with Nigeria curriculum, there is need for the adoption of responsive curriculum development and employ this curriculum strictly in Nigeria's educational system. A curriculum that is responsive is one that tackles the problem of the society and gets it solved over a period of time. Moreover, the problem of the society is the problem of the learner. Consequently, curriculum designed to eradicate those anomalies in the mind of the learner is ad-rem to the messed educational system. Curriculum that addresses nation building, integrity and nobility, a curriculum that will unravel and expose the big elephant (corruption) in the wardrobe of education industry and its system, this kind of responsive curriculum should be introduced as well as mandate it upon every student starting from lower basic to upper basic levels of education. Because early years/primary education is the foundation so if the foundation is wrong, every other thing will be wrong. Responsive curriculum should be intensified in our school system. Our educational system is under siege because of the type of curriculum in use. A curriculum that is void of affective and psychomotor domain and upholds only cognitive domain cannot equip student in this era of industrialization. Curriculum according to Idu, as quoted by Orakpo (2016), “Our curriculum is too vague and nobody wants to admit that the reason we are having high unemployment is because of our curriculum. We don’t prepare students towards specific industries. So many things are not relevant to the industry in our curriculum. When you leave out the applied aspect of a subject, how do you expect the students to cope at the end of the day? The curriculum should be designed to meet national needs, and we need a working curriculum. What we have now in Nigerian education sector is not workable, it is still way behind and incomplete. That is to say that the product of an education system, should after undergoing the curricular experiences, should be able to adjust well and fit into the society and even make something better out of the society i.e. ability to reconstructing the society (Izuagba, 2013).

In addition, the onus lies on curriculum experts to design a curriculum that is responsive to the needs of the people. Emah (2019) refers to a responsive curriculum as one that is relevant to the current and anticipated needs, problems, and aspirations of the learners. It is based on the changes in the learner's world or cultural milieu. In agreement, Law (2014) observes that global and community requirement for education includes the promotion of life-long education, re-emphasizing the quality of learner's experiences, re-organizing subjects into key learning areas so as to develop broad knowledge base, developing in learners the ability to think critically and be innovative, and having rising levels of professionalism among teachers. It could then be said that a responsive curriculum which is one that is living up to expectation, must assist the products of the Nigerian education system to appreciate the demands of the social goals, respond properly to economic realities and be able to face current and future life challenges.

Extending the aforesaid to the technological needs of the prospective learners and the society at large, it important to note that the learning environment is dynamic than ever before. As a result, today's students learn in ways that are different from how educational system was originally designed. With the advancement in Artificial Intelligence and the rise of remote/hybrid learning, the idea of the classroom is being remodeled and refined in number of ways to fit the evolving needs of modern digital learners. Based on this, many higher education institutions are substituting traditional resources with educational technologies to keep up with their digital learning. Hence, the technological needs of responsive curriculum among others include: distill actionable insights from the students' comment with AI, access to information and resources, connects the classroom experience to the real world, and prepare students for the modern workplace.

Adoption of Responsive Curriculum in Nigeria

That Nigeria is among the developing nations of the world is because of gross illiteracy that is found in the country. What then is the problem with Nigerian education system, that since the inception of formal education we are still grappling in gross illiteracy and under development? What could have been the cause of such dwindling situation in the Nigerian education industry? Is it the system, the curriculum or the method of teaching?

The educational system in Nigeria has experienced deterioration since the independent till date. The state of education has worsened to the extent that one can confidently say that no epoch has experienced the kind of dilapidation in the education industry like ours. Education in Nigeria has experienced over the years quantitative growth without complementary quality, (Edokpolo, 2011).

In the Nigerian educational system, the curriculum that is in use does not address the issue at stake or it is not responsive enough to the need of the society. Therefore, a concerted effort and a total overhauling towards our education policy is imminent at this point in time. This factor is very germane in the sense that relevant stakeholders will parley to redesign our policy in such a way that each State or Local Government will have their cherished values embellished into the school curriculum (Edokpolo, 2011). The present curriculum enthrones western culture in our land, thereby, undermining the culture and value of different states in this nation. Our educational system and value have been raped and murdered on the altar of modernization. By now, responsive curriculum that will address endemic social vices like corruption, intimidation by the so-called politicians and government officials, lack of equal right and justice, extortion, bribery, public fund embezzlement and the likes that rear their ugly heads in different ways and in different levels in education industry is quite very necessary.

The Nigeria education system is in trouble; and every day it continues to dwindle and deteriorate in essence, structure and purpose. The extent of damage that has been meted on our education is too alarming. It may not be far from the truth to say that Nigeria is plagued by so many evils today due to her comatose education sector. It's high time we all stopped apportioning blames as to who did what to bring Nigeria's education sector to her knees. Having enumerated the problems to include poor teacher training, low quality education, poor funding, high teacher/students ratio, inadequate schools, curriculum, wrong policies, poor teachers' remuneration, poor infrastructure etc., this is the time to get to work. (Orakpo, 2016). Therefore, we need to employ responsive curriculum strictly in Nigeria's educational system.

According to an empiricist philosopher, Francis Bacon "knowledge is power". Knowledge comes from education even though there is innate (derived from constitution of intellect), for one to be knowledgeable one must be educated. Therefore, no nation develops beyond the level of her education. Any positive change in the society always comes from the fruit of education. Therefore, the curriculum of any nation is the pivot of development because it is through the curriculum that the need (aims, goals and objectives) of the nation is transformed into learning experience. It then follows that for the attainment of Nigeria's development through the instrumentality of curriculum, it is imperative that curriculum designers develop a responsive curriculum which when adopted in the Nigerian schools will develop valuable human capital that is needed for economic growth and human development (Onyemesim, 2015). It will encourage indigenous production and manufacturing of local goods and raw materials. This will in turn minimize the rate of brain drain in the society. Thus, the skilled, experts and qualified professionals will no longer impoverish the nation through exportation of their skill and expertise to other countries. Corruption is a cankerworm in any society and this has eating our country Nigeria down. A responsive curriculum development should in all ramification address in her structure of learning experience the endemic epidemic in our country. If the younger generations are taught the vices and implications, consequences and penalties of corruption early enough it will go a long way to serve as a deterrent. Hence, the need for the adoption of responsive curriculum in Nigeria.

Conclusion

In a bid to produce an effective subject teaching and learning guide in the Nigerian Schools, which by implication will equip the learner with the capability, skills and potentials to be useful to himself and the society at large, it is high time we critically look into our education industry not only to sanitize the system but also to determine the type and model of curriculum that will be employed in the education system. Responsive Curriculum Development is a panacea to these myriads of problems. The problem of lack of sanity in the educational system can be solved through a pragmatic curriculum. A curriculum that tackles the problem of the learner, the needs, fears and worries of the society is what the Nigerian educational system needs. This will bring national development because as far as nation's development is involved education plays a major role. The more educated Nigerians are the faster our economy grows and our society civilized. A functional education must cater for the needs and aspirations of the nation. In this era of knowledge explosion, diverse needs and interest of the learner and the society, there is a pressing need on the curriculum to meet up the challenge. This can effectively be achieved by designing a curriculum that will take care of these needs' areas. It should be constructed in such a way that there must be integrative and interdisciplinary teaching and learning acquired from one area to solve many other problems facing them in life. The skills acquired must have utility value. The learners should acquire skills that will make them useful to themselves and the society. In order to develop competent skills, attitudes and knowledge base on critical and constructive thinking, the curriculum should be embracing, diversified and responsive to any change. This will enable the learners to adopt and adapt easily to any changing situation. The curriculum should relate to the needs of the society and skills acquisition should be emphasized. It should also be relevant to the current and anticipated needs, problems and aspirations of the learners. It's based on the occurrence and changes in the learner's world or cultural milieu.

A responsive curriculum should be properly and carefully considered and designed if ever our Nigerian Schools will be counted upon as being effective in the development and producing of sound graduates who would be useful to themselves and the society at large. Given the indisputable benefits of responsive curriculum, it's very necessary for developing countries like Nigeria to tailor their educational reforms to their peculiar cultural needs and aspirations, instead of employing imported reforms whole-hog. This view does not discountenance the credibility of some technological development in the world, but a sieving process is necessary if the main fabrics of our cultural heritage and values are not to be substantially eroded. Hence, the need for the adoption of responsive curriculum in Nigeria.

Recommendations

In view of the above discussion, the following recommendations are put forward:

1. Curriculum planners and policy makers must adopt the principles of recognizing complexity, diversity and need for action at all levels of education and in cooperation and synergy with promising trends in order to make education available and accessible to all. We should not narrow down our educational activities to the classroom only, so as not to continue producing ill-equipped

graduates with little or no practical aspect of the education that can help them perform optimally when faced with the realities of life.

2. Curriculum experts should design a curriculum that is responsive to the current needs, aspirations and problems of the people.
3. Government should motivate teachers through increase in salary and allowances so as to encourage them in putting in their best in harnessing the potentials of our future generation.
4. Teachers should prepare their teaching contents/objectives by effectively utilizing materials/ideas from learner's culture.

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RELEVANCE OF LEARNED-CENTERED EDUCATION TO THE EDUCATIONAL DEVELOPMENT OF SECONDARY SCHOOL STUDENTS IN ENUGU STATE

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Abstract

The study investigated the relevance of learned-centered education to the educational development of Enugu State. The study used mean and standard deviation to answer two research questions. Two hypotheses were tested using t-test statistics at the 0.05 level of significance. The design of the study is descriptive. With a population of 665 students, it consists of 250 respondents: one hundred fifteen males and one hundred and thirty-five females. The instrument for data collection structured by the researchers is known as the learner-centered education development (LCED). Cronbach's alpha formula was used to determine the reliability of the instrument, which has an index of 0.95 for LCED. The results showed that there was no significant difference in the mean score of male and female students on learner-centered education that contributes to the development of Enugu State. There is no significant difference in the mean score of urban and rural students on learner-centered education that empowers learners to take ownership of what they have learned. In accordance with the findings of the study, school administrators should support learner-centered management and endeavour to provide training and skills to teachers to enable the students and teachers to have higher outcomes and success.

Keywords: Relevance, Learned-Centered Education, Education and Development

Introduction

Education equips students in advance for the challenges of life. Education preserves and refines collective value anchored in the culture of society. (Bolariwa, 2014) Education provides skills, knowledge, and habits that are passed on from generation to generation, thereby becoming a collective benefit of society and effective citizenship. Education empowers students, society, and individuals to become all-round thinkers by giving them ability, attitudes, and skills; by that means, strengthening their problem-solving capability. For a learner to achieve this, they should be taught in a manner that enables them to engage in the process. Mba (2014) states that for meaningful development of any country, education is the bedrock. The role of education is important in the development of the human resources of a country. No country can develop beyond its citizenry level of education who form the country‘s human. The Nigerian government started educational programs so as to eradicate illiteracy, which impedes sustainable development. Education promotes development such as political, economic, cultural, and social emancipation of a nation. Education has three stages: primary, secondary, and tertiary. Tertiary education is important as it accelerates social change, economic sustainability, and human development. In Nigeria, tertiary education provides manpower for all human needs (Ekundayo & Ajayi (2009).

The process of teaching and learning is a vital activity for teachers and students in the school. It enables learners to undergo behavioral changes and mental development. Teaching and learning activities are conveyed by teachers and students; here, teachers display a vital role in carrying out the process, thereby making the students active learners (Ronald & David, 2001). There are two broad ways of teaching at various educational levels: the student-centered and teacher-centered method. To participate in learning, learners should be given a chance to participate actively in the learning by offering them avenues to become active learners, equipped for their future careers, college work, and undertakings in life. The classroom serves as a place for the academic growth of students. As a result, teachers perform an important role in the teaching and learning of students. They are facilitators in the delivery of curriculum, the process, and instructions. They equip, guide, and prepare the students with skills and knowledge to face the challenges and realities of the world. The departmental program in faculty should integrate and sustain learner-centered teaching for teachers to be updated on current techniques and strategies of learner-centered teaching. This will enable students to be engaged in meaningful activities through which they form attitudes, skills, and. knowledge.

According to Otukil-Mongwaketse (2018), when education is teacher-centered, the teacher controls the classroom and activities, which enables students to ask questions, express themselves, and direct their own learning. When teachers dominate the teaching and learning process, the students lose the opportunity to become more advanced as compared to when they are constructing their own skills and knowledge. Learning-centered education, noted as student-centered learning, comprises teaching methods that change from teacher instruction to students constructing their own skills and knowledge (Jones, 2007).

In the words of Hannafin (2010), the objective of learning-centered education is to change learner's autonomy and independence by handing over the obligation of learning to students by imparting knowledge and skills required to measure up performance. Learning-centered education places student's interests first and recognizes them as central to the learning experience. In learner-centered learning, students decide on what to learn, how to learn, and the assessment. Learning-centered education provides a chance for students to collaborate with one another, answer their peers's questions, and show the results of their work. Hannafin (2010) states that learning-centered education differs from traditional education; here teachers participate actively in their roles while students part-take passively in the class. In teacher-centered learning, teachers decide what the students will learn, how the students will learn, and the mode of assessment. According to Johnson (2013), student-centered learning may be referred to as an education mindset of method of instruction that takes cognizance of individual differences in learners.

Student-centered learning stresses each student's ability, learning style, and interest, having the teacher as a facilitator of learning for every student instead of the class as a whole. Karamustafaoglu (2009) emphasizes learner-centered strategies of teaching whereby students become active participants in the learning process and engage in activities like discussion, writing, problem solving, and reading that promote synthesis, analysis, and evaluation of class content. Simulation, problem-based learning, cooperative learning, and the use of case methods are some of the strategies that promote learning. When the students are actively engaged, it brings additional energy to a classroom, motivates deeper thinking of the course content, and helps the instructor pin point the problem area. Student-centered methods enable the students to develop thinking skills, such as evaluation, and give the teacher feedback to identify which learners understand and who needs help.

Statement of the Problem

Learner-centered education enables the learners (students) to take charge of what they learn by focusing on how the new knowledge adds value and solves problems. Instead of imbibing information into the child’s mind, the facilitator presents an issue and guides the students in the class as they discover solutions to the problem instead of waiting for the teacher's answer. Currently, class work needs collaborators willing to tackle and solve the problem, thus developing skills of exploring problem and taking decisions to trash the problem. Learner-centered education is an improvement over the teacher-centered educational system; it is a self-directed, project-based learning approach.

The researcher identified challenges in teachers-centered among other things were lack of confidence and interest, class size, lack of teachers and students interest, and students lack the skill of expressing their ideas. It is as a result of these problems identified in the study that researchers seek to examine the relevance of learner-centered education.

Purpose of the Study:

The main purpose of the study is to investigate the relevance of learner-centered education in educational development. Specifically the study intends to:

(1) determine the contribution of learner-centered education to the development of Enugu.
(2) identify the extent of learner-centered education and empower learners to take ownership.

Research Questions

The following research questions guide the study:

(1) To what extent does learners centered education contribute to the development of Enugu state?
(2) To what extent does learner–centered education empower learners to take ownership of what they have learnt?

Hypotheses

The following two hypotheses guide the study at .05 level of significant

HO_1: There is no significant difference in mean rating male and female learners centered education contribute to the development of Enugu state.

HO_2: There is no significant difference in mean rating urban and rural learner –centered education empower learners to take ownership of what they have learnt

Method

Design: descriptive survey design; this design involves collecting data from a sample of the population through their response to a question (Ali, 2006). The design is appropriate because it identifies, determines, or describes situations or events as they are (Ali, 2006).The area of study is the Enugu State, precisely Enugu North educational zone The choice of area is based on the researcher‘s familiarity with the location, which will grant them the opportunity to supervise and monitor the whole area. The population of the study is six hundred and sixty-five (665) students of a public secondary school in Enugu North local government area. The reason for the population is to know the relevance of learner-centered education in the educational development of Enugu State. The sample size is two hundred and fifty students (250). The sample proportion of the population was calculated using Kumar’s manual of sampling. The data collection was analyzed using the mean and standard deviation. The research used responses such as very large extent, Large extent Very small extent and. Small extent. Instruments were developed by the researcher from the data collected in this study. The instrument is learner-centered education development (LCED). The instrument was validated by three experts, one from measurement and evaluation and the others from science education, all from the University of Nigeria, Nsukka. Cronbach’s alpha internal consistency method was used to determine the reliability of the instrument. An internal consistency reliability of 0.95 was established for the instrument. Research questions were answered using the mean and standard deviation, with a mean of 2.50 as the benchmark for the decision rule. Any item with a mean score equal to or above the criterion mean of 2.50 is considered to be accepted. Any item that scores below this criterion is not accepted. Hypotheses were tested using the t-test at .05 level of significance.

Results

Research Question 1: To what extent does learners centered education contribute to the development of Enugu state?

Table 1: Learners centered education contribute to the development of Enugu state

S/N	Contribution Of Learner Centered Education To The Development Of Enugu		SD	REM
1	Develop learner's ability obtain information through research	3.12	1.14	LE
2	Enable students to gain higher level of thinking skill	3.19	0.90	LE
3	Help learner to be productive	3.32	0.85	LE
4	Help to build learner's character	3.21	0.97	LE
5	Develop learner's confidence	3.24	0.85	LE
6	Build learner's habit with regard of time management	3.33	0.86	LE
	Grand Mean	3.24		

Table 1 above represents the contribution of learner-centered education to the development of Enugu. The table discloses that mean scores range from 3.12 to 3.33. Build learner's habits with regard to time management ranked highest with a mean of 3.33 and a standard deviation of 0.86. Evidence on the table above shows that all the responses ranked positive since they fall above the minimum level of 2.50 and the overall mean score is 3.24. This indicates that learner-centered education contributes to the development of Enugu State.

HO1: There is no significant difference in mean rating between male and female learners. Learner-centered education contributes to the development of Enugu State.

Table 2 t-test analysis of there is no significant difference in mean rating male and female learners centered education contribute to the development of Enugu state

Table 2: Summary of t-test analysis on the mean rating scores of male and female students on: learner-centered education contributes to the development of Enugu state

Variables	**N**		**SD**	**Df**	**tcal**	**Sig.**	**Dec**
Male	1 15	3.24	.894	248	.348	.287	NS
Female	135	3.20	.844				

Key: N = sample size, mean, S = Standard Deviation, df = Degree of Freedom, Dec = Decision, NS = Not Significant

Data in table 2 showed that an independent-sample t-test was conducted to test the mean rating of male and female students on learner-centered education contribute to the development of Enugu state. The mean and standard deviation as shown in the table are male (=3.24, SD =.894) and female (=3.20, SD =.844). From the result of the t-test, it was found that the calculated value (0.348) is less than the tabulated value (1.660). Therefore, we fail to reject the null hypothesis that there is no significant difference in the mean score of male and female students on learner-centered education that contributes to the development of Enugu State.

Research Question 2: To what extent does learner-centered education empower learners (students) to take ownership of what they have learned?

Table 3: Learner-centered education empowers learners to take ownership of what they have learned

S/N	learner –centered education empower learners to take ownership of what they have learnt		SD	REM
1	Learners are engaged actively	3.12	I.i4	L E
2	Learners bear responsible for their own learning	3.21	0.97	L E
3	Learners study how to learn	3.32	0.85	L E
4	Learners form habits for life long learning	3.33	0.86	LE
5	Student retain understanding and knowledge.	3.32	0.85	L E
6	Learner acquire social skills by working with others.	3.16	0.92	L E
	Grand Mean	3.24		

The Table above represents learner-centered education that empowers learners (students) to take ownership of what they have learned. The Table discloses that the mean score ranges from 3.12 to 3.33. Learners form habits for lifelong learning ranked highest with a mean score of 3.33 with a standard deviation of 0.86. Evidence on the table above shows that all the responses ranked positive since they fall above the minimum level of 2.50 and the overall mean score is 3.24. This indicates that learner-centered education empowers learners (students) to take ownership of what they have learned.

HO_2 There is no significant difference in the mean rating between urban and rural learner-centered education. Learners-centered education empowers learners to take ownership of what they have learned.

Table 4: Summary of t-test analysis on the mean rating scores of urban and rural students on learner-centered education empowers learners to take ownership of what they have learned.

Variables	N		SD	Df	tcal	Sig.	Dec
Urban	150	3.21	.887	245	-1.257	.155	NS
Rural	100	3.35	.754				

Key: N = sample size , = mean, S = Standard Deviation, df = Degree of Freedom, Dec = Decision, NS = Not Significant

Data in table 4 showed that an independent-sample t-test was conducted to test the mean rating of male and female students on learner-centered education that empowers learners to take ownership of what they have learned. The mean and standard deviation as shown in the table are male (=3.21, SD =.887) and female (=3.35, SD =.754). From the result of the t-test, it was found that the calculated value (-1.257) is less than the tabulated value (1.660). Therefore, we fail to reject the null hypothesis that there is no significant difference in the mean score of urban and rural students on learner-centered education that empowers learners to take ownership of what they have learned.

Discussion of the Findings

Education is important in the development of any country. Teaching and learning empower the learner to comprehend the world he lives in and be curious about it. It is necessary to lay emphasis on different teaching methods that enable the learners to improve on academics as well as solve their problems. Learner-centered education, to a large extent, has made a contribution to the development of education in Enugu State. There is no significant difference in the mean score of male and female students on learner-centered education contributing to the development of Enugu State; this indicated that learner-centered education builds up desire for learner's lifelong learning, retains, maintains knowledge, and acquires actively social skills while working with other people. Learning-centered education enables the learner to be independent and autonomous in handling his responsibility in learning. This is in accordance with Hannafin (2010), who said that learning-centered education develops learner's independence and autonomy by handing over responsibility for learning to students by imparting knowledge and skills required to measure up performance**.** There is no significant difference in the mean score of urban and rural students on learner –centered education empower learners to take ownership of what they have learnt. Learner centered education empower (students) to take ownership of what they have leant this indicate, students construct meaningfully their own skills and knowledge. This enables students to be engaged in meaningful activities through which they develop their attitudes, knowledge and skill. This is aligned with

Jones's (2007) state that student-centered learning includes teaching methods that shift from teacher instruction to students constructing their own skills and knowledge. This is aligned with Jones's (2007) state that student-centered learning includes teaching methods that shift from teacher instruction to students constructing their own skills and knowledge. In learner-centered learning, students are motivated and encouraged to reflect on learning materials and partake in collaboration at the appropriate time. Learners are instructed individually. Moreover, while working with others, they gain skill, form a desire for a long life, and the learner takes charge of their own understanding.

Conclusion:

The way teachers handle students creates imparts on students to support the learning process. Teachers' strategies and approaches influence the students' learning strategies and skills; hence, teachers are encouraged to be more learner-centered in their teaching. When teachers teaching methods are more learner-centered in the class, the learning strategies and skills increase greatly because teachers provide more methods to enhance the learning strategies and skills of the students. Learner-centered Is an approach for students to develop their learning by doing? It is essential that learners are involved and engaged in their learning process; this will enable them to adapt learning strategies and skills and become responsible learners.

Recommendations:

The following recommendations were made based on the findings.

There is a need for school administrators to support learner-centered management and endeavor to provide training and skills to teachers; this enables the students and teachers to have higher outcomes and success. Further, classrooms have students of different learning styles and needs; hence, teachers should use individualized student-centered classroom management techniques to ensure all students are successful.

In the implementation of learning-centered education, there is a need to address the issue of dilemmas; these include class size, curriculum design, shortage of teachers, and shortage of instructional resources and facilities.

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AWARENESS AND UTILIZATION OF IMPROVISATION STRATEGY IN THE TEACHING AND LEARNING OF CHEMISTRY IN ENUGU EDUCATION ZONE OF ENUGU STATE

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Abstract

This study investigated the awareness and utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone of Enugu State. Two research questions and four null hypotheses guided the study. The researcher adopted census survey research design for the study. The total population of 114 chemistry teachers in Enugu Education Zone participated in the study. The researcher developed a self-structured instrument called "Awareness and Utilization of Improvisation Strategy Scale (AUISS). The instrument has two sections, A and B. Section A is on the respondents bio-data while section B has 2 parts with 30 items. The instrument was a 4 point scale of very great extent, great extent, little extent and very little extent. The instrument was validated by three research experts. The researcher used Cronbach Alpha reliability estimate to analyze the data collected and a coefficient of .68, and .75, were obtained for clusters 1and 2, respectively. The overall reliability index stood at .86. Mean and Standard Deviation were used to answer the research questions while t-test was used to test the four null hypotheses that guided the study at 0.5 level of significance. The result of this study indicated that chemistry teachers in Enugu Education Zone of Enugu State are to a great extent aware of improvisation strategy in teaching and learning of chemistry in Enugu Education Zone of Enugu State, however the result indicated that to a great extent chemistry teachers in Enugu Education Zone of Enugu State utilized improvisation strategy in teaching and learning of chemistry in Enugu Education Zone of Enugu State. Gender of the chemistry teachers' was not found to have affected the chemistry teachers' extent of awareness and utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone. Whereas, location of the chemistry teachers was found to have affected the chemistry teachers' extent of awareness of improvisation strategy. More so, location of the chemistry teachers was found to have not affected the chemistry teachers' extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone of Enugu State. The researcher recommended that deliberate efforts should be made at supervising the utilization of improvisation strategy in teaching and learning chemistry in secondary schools in Enugu Education Zone of Enugu State.

Keywords: *Awareness, Utilization, Improvisation Teaching, Learning, Chemistry*

Introduction

Education all over the world is regarded as an indispensable tool for enhancing economic growth and national development. It is seen as the cornerstone of development because it forms the basis of literacy, skill acquisition, technological advancement, knowledge acquisition and ability to harness the natural resources of the environment (Okoro, 2014). Antai and Anam (2019) asserted that education nurtures better citizens and helps to upgrade the general standard of living in a society. The education sector in any country is very important because education supplies the skilled manpower needed for the achievement of national economic goals and objectives. In the view of Adeogun (2010), education is a major instrument for tackling unemployment, poverty and ignorance. It is on this basis that the Federal Republic of Nigeria (FRN, 2013) outlined in her National Policy on Education, the cardinal aims of education which include among others;

> the development of the intellectual capacity of individuals to understand and appreciate their environment; and the acquisition of both physical and intellectual skills which will enable individuals develop into useful members of the community. These skills are acquired in formal education settings from primary, secondary and tertiary institutions such as universities, polytechnics and colleges of education. For the purpose of this study, the focus will be on secondary education.

The secondary education is one aspect of educational institutions in Nigeria that is designed specifically to train and prepare students for middle-level services in both manufacturing and service industries. One of the objectives of secondary education according to Atuyi (2019) is the acquisition of both physical and intellectual skills which will enable individuals to be self-reliant and useful members of the society. It must be emphasized that secondary education in Nigeria is for six years duration, junior secondary school (3 years) and senior secondary school (3 years). The two stages are both vocational and academic in nature. The broad goal of secondary education as stated in the National Policy on Education is to prepare the individual citizen for useful living within the society and preparation for higher education (FRN, 2013). Chemistry is one of the core science subjects taught in the senior secondary.

Chemistry has been defined as a science of nature that deals with the properties of non-living substances, whose properties ranges from the preparation and changes that they undergo when such substances are subjected to adverse conditions of high temperature, high pressure, extreme cold and abnormal contact (Iheanyi, 2015). It is concerned with the impartation of knowledge on properties, components, transformations and interactions of matter (Emendu, 2014). Chemistry Education is therefore the systematic process of acquiring the fundamental knowledge about the universe. The importance of chemistry education to national development can never be over-emphasized. The teaching of chemistry helps to imbibe scientific knowledge and stimulate science-oriented attitude in learners. Undoubtedly, this attitude when directed to the world of work results in the development of the individual, the society and general standard of living of the citizenry. Therefore, the place of chemistry knowledge and skills in economic and industrial development in the Nigerian society cannot be underestimated.

Chemistry is seen as a difficult subject for many students containing many abstract concepts which are central to further learning in both chemistry and other science related discipline (Fatokun, Egwa & Uzoechi (2016). These abstract concepts are important because complex chemistry concept or theories cannot be easily understood if these underpinning concepts are not sufficiently grasped by students. Concepts such as dissolution, particulate nature of matter, periodicity, formulae and equations, chemical bonding are fundamental to learning chemistry. The root of many difficulties that students have in learning chemistry is traceable to inadequate understanding of these fundamental topics such as the periodicity (Olaniyan, 2018). Olaniyan further noted that most chemistry candidates for external examinations displayed inability to accurately write down chemical formula and balance simple equations. This is because students were not properly grounded in periodicity and balancing of equations. Weiss, Knowlton and Morrison (2017) also noted that many students have difficulties in recalling the position of elements in the periodic table and connecting the elements to their physical and chemical properties.

It must be emphasized that to ensure effective teaching and learning of Chemistry, lots of chemicals and equipment are required. It is on this basis that Ezeano (2012) opined that equipment can be used over and over again but the chemicals are expendables which are normally poured into sink after practical lessons. Sadly, most of the expendables are costly and always in short supply. Ezeano, further noted that the high cost and scarcity of chemicals do not permit effective teaching and learning of Chemistry and improved academic achievement. It is an obvious fact that chemicals or expendables are in short supply and practical lessons are being omitted as a result. Such being the case, there is need to seek for an alternative strategies of teaching Chemistry. Alternative teaching strategies that permit the use of locally available materials need to be sought to ensure that students are exposed to requisite chemistry experiences. Such alternative teaching strategies is referred to as cost reducing teaching strategies. Cost reducing strategies according to Ezeano (2012) include judicious use of expendables, small scale experiment, improvisation, among others, these strategies can be applied so that students will be effectively taught even during scarcity of teaching materials.

Improvisation is a method of cost reducing strategy in teaching and learning of chemistry. Improvisation as defined by Mogbo in Ezeano (2012) is the construction or creation of cheap and simple alternatives by the chemistry teachers in order to make the teaching and learning processes easier. Balogun (2015) defined improvisation as the act of using alternative materials and resources to facilitate instruction wherever there is lack or shortage of specific firsthand teaching aid. It is the use of products of look-alike object to facilitate instruction. Adeniyi (2016) viewed improvisation as to adopt materials for use where normally other conventional items are employed. Nwaeze (2017) advocated two forms of improvisation, role substitute and role simulation. The role substitution form entails modification of the original materials in order to perform its function in an experimental setting. The role simulation form involves the actual construction of apparatus discarded materials or preparation of a new but a substitute material that can stand in place of the conventional one.

Improvisation involves the production of alternative materials to serve as a substitute in place of an existing but not available laboratory materials. Idris (2020) noted that materials for improvisation can be found in homes incinerators, market, school, welder's workshop and mechanic's workshop. Adeniyi (2016) stated that improvised materials which can be used in teaching practical chemistry among others include: malta bottles for reagents bottles, hibiscus flower pigment for indicator, methylated spirit lamp for bursen burner and other collection of chemical reagents from local resources. Idris (2020) suggested that plastic jerry can be used for stocking solution, transparent plastic cups for beakers and locally made Kepp's apparatus for standard Kipp's apparatus. Aronson (2013) asserted that broomsticks with plasticine rolled into ball can be used for molecule models and ear or eye-drops containers can serve as dropping pipette for indicators. Improvisation when applied helps to make available the needed materials for teaching and learning of chemistry in general and practical in particular (Ezeano, 2012). Improvised materials are cheaper than the conventional ones. It replaces the costly unavailable materials and helps in the achievement of learning objective. Idris (2020) noted that improvisation is more in use in the rural areas than the urban areas where conventional equipment are available in the various schools. Improvisation presents to the learners the properties as the real instructional materials in teaching learning process. Improvised materials according to Nwabunwanne (2011)

> Provide very rich visual experiences to all learners and afford them the opportunity of teaching and manipulating materials for direct concrete experiences.
>
> Promote quick understanding by arresting learners attention and give first-hand experience which are not easily forgotten to students, stimulate creative expressions in pupils and encourages active participation in the lesson.
>
> Afford the students the opportunity of individualized study and hence promote individualized instruction in chemistry teaching and learning.

Improvisation strategy may help to ameliorate the difficulties encountered by teachers during instructional delivery as noted by (Ibe, 2017). The question still remains whether the chemistry teachers are aware of improvisation strategy and the extent to which they utilize it in instructional delivery which would enhance teaching and learning of chemistry concepts. The Chemistry teachers need to be aware of the existence of improvisation strategy so as to enable them fully utilize it in order to enhance effective teaching and learning in Chemistry. This is very important because, there is hardly any time the needed teaching materials are adequate in the secondary schools.

Awareness is defined as a human perception and cognitive reaction to a condition or event (Ezeano,2012) It is the knowledge or understanding of a particular subject or situation. Awareness in ordinary parlance means one having knowledge of the existence and usefulness of something. Reimer and Haines (2013) defined awareness as knowing who is around, what activities are going on and who is talking with whom. Apart from the chemistry teachers being aware of improvisation strategy there is the need for the utilization it. If the chemistry teachers are aware of improvisation strategy and fail to utilize them as a cost reducing strategy, it will do no good to teaching and learning. Improvisation strategy need to be effectively utilized by chemistry teachers so as to bridge the gap created by scarcity of teaching materials and enhance effective teaching and learning of Chemistry.

Utilization means the act or process of using a particular thing, idea or method for the actualization of a purpose (Hornby, 2010). Utilization of resources refers to the equitable use of resources accruable to an enterprise especially in the education industry for effective implementation of school curriculum (Nwabunwanne, 2012). Utilization of improvisation strategy in instructional delivery by Chemistry teachers requires teachers' knowledge of the various alternative instructional facilities, as well as an understanding of how students learn using varied improvisation strategy in teaching and learning (Petterson, 2011).Consequently, Ogbuegbuna-Okwenu (2014),opined that the non-use or underutilization of instructional facilities in schools is attributable to the teacher, explaining that facilities in education do not on their own achieve any meaningful values without being effectively utilized. The same could also be applicable to the utilization of various improvisation strategies. Thus, improvisation strategy will not on its own achieve any meaningful goal without being put into effective use by Chemistry teachers.

One influencing factor in the context of awareness and utilization, of any resources, in teaching and learning including improvisation strategy in instructional delivery is gender. Gender is the range of characteristics pertaining to and differentiating between masculinity and femininity (Ibe, 2018). Research has shown that gender issues affect all aspects of the society as regarding their profession, competencies in higher institution and so on, which actually reflects biasness in their performance level (Onuzulike, 2011). Although independent researches like Ibe (2018) and Onuzulike (2011) have found male performing better than female in the use of improvisation, a few others like Loyd and Gressand (2020) discovered that female out-performed the male, while some others established no significant difference use of improvisation, particularly in teaching and learning (Adeleke, 2016). Onuzulike (2011) stated that, gender has been identified as a critical factor that affects teachers' attitudes towards the use of improvisation in teaching of chemistry. Therefore, considering gender in this study could yield useful practical information based on the controversy on issue of gender. There could be a significant difference in the level of awareness and utilization of improvisation strategy between male and female Chemistry teachers.

Another factor that may influence the awareness and level of utilization of improvisation strategy in instructional delivery in secondary schools is location. This has to do with the area or place the school is located. The school location also refers to whether the school is in Urban or in the Rural areas. Location may be defined as a place of settlement, activity or residence. Ibe (2018) noted that schools located at the urban areas are better financed and funded than those in the rural areas. Wagner, Hassanein and Head (2014) pointed out that the utilization of instructional resources, improvisation strategy inclusive in institutions is influenced by schools location which could make the procurement of instructional resources by these institutions difficult or easy, as the case may be. Also, noteworthy is the fact that the availability would also go a long way in determining the extent of awareness of the existence of the improvisation strategy. Thus, the awareness and utilization of improvisation strategy in secondary schools might differ. The rural and urban schools may differ in the quality of cost reducing strategies applied in the teaching and learning of Chemistry (Leem & Lim, 2017).

Considering the fact that the use of improvisation strategy in teaching and learning of chemistry may go a long way to improve teaching and learning of chemistry as well as practical teaching of chemistry, therefore it is essential to determine the extent to which chemistry teachers are aware of and the extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone of Enugu State.

Statement of the Problem

The nature of Chemistry demands that it should be taught practically, but the practical Chemistry lessons are rarely done effectively in most schools due to insufficiency of laboratory materials. Since the instructional materials for teaching and learning of Chemistry are in short supply it may lead to poor achievement in both internal and external examinations.

There is need for alternative teaching strategy which can allow effective teaching of Chemistry even when the conventional teaching materials are not adequately provided. Alternative teaching strategy such as improvisation can be useful.

More so, Chemistry could be taught even during the period of scarcity of conventional instructional materials and can help to remove the lapses that have led to poor exposure of students to practical experiences. Hence this study focuses on improvisation strategy to ensure that practical chemistry expendables are available. The issue still remains whether the chemistry teachers are aware and will be able to utilize the improvisation strategy, consequent upon these, the problem of this study put in question form is; To what extent are Chemistry teachers aware of and can utilize improvisation strategy in the teaching and learning of chemistry in Enugu Education Zone?

Purpose of the Study

The purpose of the study is to determine Chemistry teachers' awareness and utilization of improvisation strategy in teaching and learning of Chemistry in secondary schools in Enugu Educational Zone of Enugu State. Specifically, the study sought to determine the;

1. extent of chemistry teachers' awareness of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.
2. extent of chemistry teachers' utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Research Questions

The following research questions guided the study;

1. To what extent are chemistry teachers' aware of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone?
2. To what extent do chemistry teachers' utilize improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone?

Hypotheses

The following null hypotheses were formulated and tested at .05 level of significance.

Ho$_1$: There is no significant difference in the mean response scores of male and female chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Ho$_2$: There is no significant difference in the mean response scores of male and female chemistry teachers on their extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Ho$_3$: There is no significant difference in the mean response scores of urban and rural chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Ho$_4$: There is no significant difference in the mean response scores of urban and rural chemistry teachers on the extent they utilize improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Method

The researcher adopted census survey research design for this study. According to Idoko (2011) census survey research design is one which data is collected from every member of the target population. It is a design of statistical enumeration where all member of the population are studied. The census survey research design is therefore considered most appropriate for this study because it allows the researchers to collect the original data and describe their condition as they exist in their natural setting. The population for the study is made up of 114 chemistry teachers currently serving in the 31 Government owned secondary schools in Enugu Education Zone. Among them are 38 male and 76 female teachers. This is based on the data obtained from the Post Primary School Management Board Enugu *(PPSMB, 2021/2022).* The total population of 114 was used for the study. No sampling was done. The researcher developed a self-structured instrument with the title “Awareness and Utilization of Improvisation Strategy Scale”, (AUISS). The instrument has two sections; A and B. Section A contains the respondents’ personal information while section B is divided into two clusters with 30 items structured to assist the researcher in providing clues to the research questions that guided the study. Cluster 1 is on extent of chemistry teachers’ awareness of improvisation strategy with 15 items. Cluster 2 is on extent of chemistry teachers’ utilization of improvisation strategies with 15 items. The response format for the instrument is a 4 point scale of Very Great Extent (VGE)=4 points: Great Extent(G E) =3 points: Little Extent (LE)=2points. VeryLittle Extent(VLE)=I point.

The instrument was validated by three experts, two from Department of Science Education, and one from the Measurement and Evaluation unit, Mathematics and Computer Department, all from the Faculty of Education in Enugu State University of Science and Technology. The researcher conducted a trial test using 20 respondents from Secondary schools in Agbani Education Zone. The respondents were assured of complete confidentiality of all information they supplied they were allowed to complete the instrument at their own convenience. The responses to the various items of the questionnaire were used in computing its reliability using Cronbach’s alpha reliability estimate. The overall reliability index stood at .86 indicating that the instrument is highly reliable and suitable for the study. The researcher administered the instrument directly to the 114 respondents using two research assistants. The research assistants were briefed by the researchers on the conduct of the exercise, during which they were acquainted with the purpose of the study and how the questionnaire should be administered and collected. Appointments were booked with the respondents for collection at a later day for those who were not able to fill their own copies of the instrument because of the nature of their job. The researcher and the research assistants were able to retrieve all the 114 copies of the distributed questionnaire instrument, signifying 100% return rate. Data collected were analyzed using mean with standard deviation in order to answer the research questions. The null hypotheses were tested using t-test statistics at.05 level of significance. For the decision rule, all the items with mean score of 2.50 and above were accepted while those with mean score below 2. 50 were rejected. For the hypotheses, if the p-value at .05 level of significance is less than t-value or critical value of the t-test, the null hypothesis was not rejected, but if otherwise the null hypothesis was rejected.

Results

Research Question 1: To what extent are chemistry teachers aware of improvisation strategy in teaching and learning of chemistry in secondary school in Enugu Education Zone?

Table 1: Mean responses and standard deviation of the respondents on the extent of chemistry teachers' awareness of improvisation strategy in teaching and learning of chemistry in secondary school in Enugu Education Zone.

N=114

S/N	Extent of chemistry teachers awareness of improvisation strategy in teaching and learning of chemistry include being aware that;	VGE	GE	LE	VLE	$\bar{X}$	SD	DEC
1	malt bottles can replace reagent bottles	42	34	38	0	3.04	0.84	GE
2	Kerosene stove can stand for burner	41	32	39	2	2.98	0.88	GE
3	Plastic jars can stand for glassware	36	45	32	1	3.02	0.79	GE
4	Improvised pH paper to test the pH of acid-based solution	31	31	31	21	2.63	1.07	GE
5	Acid-base indicator can be gotten from red-cabbage juice	22	32	28	32	2.39	1.09	LE
6	flat pieces of metal can replace spatulas	42	42	25	5	3.06	0.88	GE
7	eye-drop containers can serve as dropping pipette for indicator	32	24	35	23	2.57	1.10	GE
8	teaspoon can stand in place of burette in titration experiment	19	35	25	35	2.33	1.08	LE
9	Graduated transparent plastic cups can be for beakers	34	44	36	0	2.98	0.79	GE
10	NaOH can be gotten from the ash of cassava peels	31	30	31	22	2.61	1.08	GE
11	KOH can be gotten from the ash of palm husks	24	34	27	29	2.46	1.09	LE
12	meter rule pivoted at the centre to show change in mass	43	41	30	0	3.11	0.79	GE
13	hibiscus flower pigment can be for indicator	47	34	33	0	3.12	0.83	GE
14	wooden spatula can stand in place of metal ones	43	42	24	5	3.08	0.87	GE
15	white sedimentary rock (nzu) for C_aCO_3	28	22	37	27	2.45	1.11	LE
	Grand Mean					**2.80**	**0.95**	

From Table 1 above, the results of data analysis for research question 1 indicated that items (1,2,3,4,6,7,9,10,12,13 and 14) had mean responses that were higher than the cut-off point of 2.50.Only items (5,8,11,and15) had mean responses that were below the cut- off point of 2.05. The value of the grand mean was also high. This means that the respondents agreed that chemistry teachers appear to be aware of improvisation strategy to a great extent in teaching and learning of chemistry in secondary school in Enugu Education Zone.

Research Question 2

To what extent do chemistry teachers utilize improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone?

Table 2: Mean responses and standard deviation of the respondents on the extent chemistry teachers utilize improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

N = 114

S/N	Chemistry teachers utilization of improvisation strategy include: chemistry teachers utilize	VGE	GE	LE	VLE	$\bar{x}$	SD	DEC
16	malt bottles for reagent bottles	41	36	36	1	3.03	0.85	GE
17	Kerosene stove for burner	37	35	41	1	2.95	0.85	GE
18	Plastic jars for glassware	29	47	38	0	2.92	0.77	GE
19	Improvised PH paper to test the PH of acid-based solution	35	42	37	0	2.98	0.79	GE
20	Acid-base indicator from red-cabbage juice	35	42	37	0	2.98	0.79	GE
21	flat pieces of metal as spatulas	56	58	0	0	3.50	0.50	GE
22	eye-drop containers as dropping pipette for indicator	29	47	38	0	2.92	0.77	GE
23	teaspoon in place of burette in titration experiment	35	42	37	0	2.98	0.79	GE
24	Graduated transparent plastic cups for beakers	56	58	0	0	3.49	0.50	GE
25	NaOH from the ash of cassava peels	29	47	38	0	2.92	0.77	GE
26	KOH from the ash of palm husks	29	47	38	0	2.92	0.77	GE
27	meter rule pivoted at the centre to show change in mass	29	48	37	0	2.93	0.76	GE
28	hibiscus flower pigment for indicator	29	48	37	0	2.93	0.76	GE
29	wooden spatula in place of metal ones	27	37	24	26	2.57	1.08	GE
30	white sedimentary rock (nzu) for C_aCO_3	27	3	24	26	2.57	1.08	GE
	Grand Mean					**2.97**	**0.78**	

From Table 2 above, the mean responses to the items (16-30) were higher than the cut-off point of 2.50, mining that the respondents agreed that the chemistry teachers to a great extent appear to utilize improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Hypothesis 1: There is no significant difference in the mean response scores of male and female chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning chemistry in secondary schools in Enugu Education Zone.

Table 3: t-test on the mean ratings of male and female chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning chemistry in secondary schools in Enugu Education Zone.

Gender	N	Mean	Std. Deviation	t	df	Sig.	Dec.
Male	38	2.70	1.092	1.303	112	.193	NS
Female	76	2.57	1.093				

Table 3 shows that the t value for the difference in mean rating of male and female chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning chemistry in secondary schools in Enugu Education Zone is 1.303, significant at .193 level of significance, which is higher than 0.05 set for the study. The null hypothesis is therefore not rejected. This means that there is no significant difference in the mean ratings of male and female chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning chemistry in secondary schools in Enugu Education Zone, as perceived by the teachers.

Hypothesis 2: There is no significant difference in the mean response scores of male and female chemistry teachers' extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Table 4: t-test on the mean ratings of male and female chemistry teachers' extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Gender	N	Mean	Std. Deviation	T	df	Sig.	Dec.
Male	38	2.64	1.09	.676	112	.289	NS
Female	76	2.56	1.123				

Table 4 shows that the t value for the difference in mean rating of male and female chemistry teachers extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone is .676, significant at .289

level of significance, which is higher than 0.05 set for the study. The null hypothesis is therefore not rejected. This means that there is no significant difference in the mean ratings of male and female chemistry teachers extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone, as perceived by the teachers.

Hypothesis 3: There is no significant difference in the mean response scores of urban and rural chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning chemistry in secondary schools in Enugu Education Zone.

Table 5: t-test on the mean ratings of urban and rural chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning chemistry in secondary schools in Enugu Education Zone.

Location	N	Mean	Std. Deviation	t	Df	Sig.	Dec.
Urban	97	2.54	1.090	-4.573	112	.000	S
Rural	17	3.00	.803				

Table 5 shows that the t value for the difference in mean rating of urban and rural chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning chemistry in secondary schools in Enugu Education Zone is -4.573, significant at .000 level of significance, which is higher than 0.05 set for the study. The null hypothesis is therefore rejected. This means that there is significant difference in the mean ratings of urban and rural chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning chemistry in secondary schools in Enugu education zone, as perceived by the teachers.

Hypothesis 4: There is no significant difference in the mean response scores of urban and rural chemistry teacher's extent of utilization improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Table 6: t-test on the mean ratings of urban and rural chemistry teacher's extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Location	N	Mean	Std. Deviation	T	Df	Sig.	Dec.
Urban	97	2.99	.845	.523	112	.596	NS
Rural	17	2.94	.814				

Table 6 shows that the t value for the difference in mean rating of urban and rural chemistry teachers extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone is .523, significant at .596 level of significance, which is higher than 0.05 set for the study. The null hypothesis is therefore not rejected. This means that there is no significant difference in the mean ratings of urban and rural chemistry teacher's extent of utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Discussion of the Findings

Research question one, attempted to elicit the perception of the respondents on the extent chemistry teachers are aware of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone. Out of fifteen items articulated to answer the research question posed only four items got a mean point that indicated little extent. This shows that chemistry teachers to a great extent are aware of improvisation strategy in teaching and learning of chemistry in Enugu Education Zone. This finding agrees with Iheanyi (2015) which stated that chemistry teachers are to a reasonable extent aware of the cost reducing strategies which includes improvisation but are hindered by both personal reasons and environmental constraints. Therefore, there is need for an increased emphasis on improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.

Comparison between the mean response scores of male and female chemistry teachers and their extent of awareness of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone showed that there is no significant difference in the mean rating of male and female chemistry teachers and their extent of awareness of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone. This finding is in line with Utibe-Abasi (2015) noted that problems faced by teachers in the awareness and utilization of improvisation were not gender sensitive.

Similarly, on the influence of location of schools, it was found in this study that there is significant difference in the mean rating of urban and rural chemistry teachers on their extent of awareness of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone. This finding is in line with Leem and Lim (2017) which stated that rural and urban schools may differ in the quality of awareness and utilization of cost reducing strategies applied in the teaching and learning of chemistry Adeniyi (2016) observed that urban based chemistry teacher are to a great extent aware and apply cost reducing strategies such improvisation then their rural counterparts.

Research Question two which investigated the extent of chemistry teachers' utilization of improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone showed that chemistry teachers to a great extent utilize improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone of Enugu State. This finding agrees with Nweze (2017) who noted that chemistry teachings in Nigeria use substitutes when the conventional chemicals are not found. Ezeano (2012) opined that improvised materials are cheaper than the conventional ones. It replaces the costly unavailable materials and help in the achievement of learning objective.

Investigation for significant difference between the mean response scores of male and female chemistry teachers on the extent to which they utilize improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone showed that there is no significant, difference in the mean rate of male and female chemistry teachers on the extent to which they utilize improvisation strategy in teaching and learning of chemistry in Enugu Education of Enugu State. This finding is in consonance with Utibe-Abasi (2015) who stated that problems faced by teachers in the awareness and utilization of improvisation were not gender and location sensitive. Utilization of improvisation as a cost reducing strategy in instructional delivery by both male and female chemistry teachers requires teacher's knowledge as well as understanding of how students learn using varied cost reducing strategy in teaching and learning.

Comparism between the mean rating of urban and rural chemistry teachers on the extent to which they utilize improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone indicated that there is no significant difference in the mean rating of urban and rural chemistry teachers on the extent of utilization of improvisation strategy in teaching and learning of chemistry in Enugu Education Zone of Enugu State. This finding agrees with Utibe-Abasi (2015) who revealed that gender and location do not constitute constraints in the use of improvisation in teaching and learning. Utibe-Abasi further noted that problems faced by teachers are not gender and location sensitive.

Recommendations

Based on the findings and implication of the results, the following recommendation was made:

1. Improvisation strategy should be highly emphasized and encouraged by the stake holders in education for secondary schools in Enugu Education Zone
2. Deliberate efforts should be made by education supervisors in ensuring that the chemistry teachers utilize improvisation strategy in teaching and learning of chemistry in secondary schools in Enugu Education Zone.
3. The school authorities should, on a regular basis, organize seminars, workshop and enlightenment programmes on utilization of improvisation strategy in teaching and learning of chemistry in secondary schools Enugu Education Zone.
6. There should be an increased awareness of improvisation strategy by the ministry of education in secondary schools in Enugu Education Zone of Enugu State.

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SOCIAL COMPETENCE AND GENDER AS PREDICTORS OF JUNIOR STUDENTS' ACADEMIC ACHIEVEMENT IN BASIC SCIENCE IN ENUGU STATE

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Abstract

The study investigated social competence and gender as predictors of junior secondary school students' academic achievement in basic science in Enugu state. Three research questions and three null hypotheses guided the study. The predictive correlation design was adopted for the study. The population of the study was 9,192 upperbasic science students in Enugu state. The sample size for the study was 1000 students drawn using multi-faceted sampling procedure involving purposive and random sampling techniques. The instrument for data collection was Students' Social Competence Scale. The students' achievement scores in Basic science were obtained from the teachers' score folder. Data generated from the study was analysed using simple and multiple linear regressions. The findings of the study revealed among others that 1.6% and 1.1% of the variance in achievement in Basic science was attributed to social competence and gender of Basic science students' respectively. Also, achievement scores in Basic science were significantly predicted by social competence and gender, individually and jointly. It was recommended that basic science teachers should ensure that the atmosphere within the classroom is gender friendly enough, making sure that both male and female students have a conducive social atmosphere to be actively involved in learning Basic science.

Keywords: *Social- Competence, Gender, Basic-Science, Achievement, Predictor*

Introduction

Learning is often a difficult activity especially for a new concept. Learners may however learning very easily if someone has learnt what they are trying to learn and guides them in their own leanring. Students as a result may either continue or cease any profitable academic behaviours depending on how they are reinforced or rewarded within the social environments of the school and the atmosphere within the classroom. Students by observing the teacher or fellow students as model, pay attentions to the skills they have, retain them in order to reproduce and are motivated; and reinforce those skills depending on the rewards that proceed from them (Amna, 2021). The whole tenet of the social learning theory therefore is founded on the idea that learning is a social endeavor that must happen within a social context. The social learning theorists hold that meaningful learning barely occurs in isolation and therefore, learners require certain level of social competence to thrive academically.

Social competence refers to the broad set of emotional, social, and cognitive skills needed for adaptation to a diverse array of developmental contexts and challenges (Anisa, Suganda & Jaya, 2019). Social competence according to Bajer (2015) is the effectiveness or skill in interpersonal relations and social situations, increasingly considered an important component of mental health. It involves the ability to evaluate social situations and determine what is expected or required; to recognize the feelings and intentions of others; and to select social behaviours that are most appropriate for that given context. It is important to note, however, that what is required and appropriate for effective social functioning is likely to vary across settings. In academic settings, when students face challenges in learning, interpersonal social competence is necessary for obtaining assistance from both teachers and peers (Franco, Beja, Candeias & Santos, 2017). Learners with higher in social competence develop social support networks, which provide for higher academic achievement which are often achieved through interpersonal communication.

When students know how to communicate their ideas, listen to what others have to say, and cooperate with others, they have a far easier time achieving success in the classroom and in most academic task. Unsurprisingly, students who learn proper social skills demonstrate far more positive behaviours and far fewer negative ones both in their personal lives and their academic ones (Junge, Valkenburg, Deković & Branje, 2020). Cooperating with peers according to Franco et al. (2017) is a necessary skill in order for students to work productively to overcome problems and develop solutions. Whether it is conflict resolution or learning to understand others' points of view, social skills help students work with their peers and motivate each other to reach goals by listening actively.

Students may find it difficult to learn when they listen inattentively or are only paying some attention or even none at all in their class. Learning thus requires active listening (Hoffman et al., 2021). Active listening means consciously and intentionally listening to a speaker, such as a student's teacher. However, active listening can be quite difficult, particularly for students who struggle with social competence. By learning to actively listen, students as Hoffman et al. (2021) noted can comprehend more of what they hear and respond more thoughtfully, greatly improving their ability to learn and their performance in the classroom especially in subjects like basic science which is often perceived to be difficult among junior secondary school students.

Basic science formally known as integrated science is an approach to the teaching of science, of which concepts and principles are presented so as to express to fundamental unity of scientific thought and avoid premature or undue stress on the distinction between the various scientific fields (Nwankwo, 2020). The term "integrated science" is often used as a synonym for interdisciplinary and unified science, which may be applied generally to any curriculum effort in which two or more previously separated science subjects are combined. It is thus important in learning science at higher level of education as it forms the foundation of science learning. At the secondary school level of education, basic science according to Agbidye (2015) poses some learning challenges to students owing to its unitive nature which is not structurally coherent given that its contents are not arranged to suit the Nigerian student. Students achievement in the subject Basic science according Nwankwo and Okoli (Adegbola, 2023) to is therefore not consistently satisfactory. Science learning as well as its application requires collaboration among learners or scientist in other to reach success. The collaboration among scientist to make novel discoveries or among science students in order to learning meaningful is not different for basic science (Adegbola, 2019). Thus students require high levels of social competence to thrive in basic science.

Studies like those of Ekpenyong, Adediran and Adeyemi (2019) showed that social competence is highly correlated with and greatly influenced school pupils' academic achievement. Shehu (2019) similarly reported in her study that social competence was a significant predictor of academic achievement in elementary school students. In a related study, Nurfadila (2019) showed that students' social competence was not a significant predictor of academic achievement in English language. The study however noted that all the dimensions of social competence; communicative, assertiveness, future orientation, critical thinking, identity formation and pro-social tendency did not significantly determine academic achievement in English language. In a contrasting study however, Amna (2021) found out that that there was no statistically significant relationship between children's social competence and their academic achievement. These disparities in research findings on the predictive association between social competence and academic achievement suggest the need for further investigation. The need for further studies is necessitated also by the gender gaps in science achievement, a phenomenon that is not alien to the learning of basic science.

Gender is usually categorized as female or male but there is variation in the biological attributes that comprise sex and how those attributes are expressed (Baker & Milligan, 2016). Gender refers to the socially constructed roles, behaviours, expressions and identities of girls, women, boys, men, and gender diverse people. There was no measurable difference detected in the average scores by gender in either the life science or physical science domains. Males outperformed females overall in science in 2003, which was also the case in 1995. Recent studies in the developed world have shown a reversal in academic performance between males and females, with females outperforming males in almost all disciplines at various levels of the educational ladder. Ani, Obodo, Ikwueze and Festus (2021) reported that gender (male/female) had no significant effect on students' achievement in basic science. Science classrooms even at the basic level can be dominated by male or female students depending on which gender has the dominant social competency skills (Bajer, 2015). There is need therefore to also examine the interaction of social competence and gender in the prediction of academic achievement of students' in basic science.

Statement of Problem

Basic science is one of the core subjects in junior secondary school, and despite its importance and efforts made by stakeholders in the educational sector to optimize the learning of basic science as a foundational science subject for students of pure science subjects and for technological advancement of the country, students' academic achievement in basic science has remained unsatisfactory. Basic Science as a subject registers a good percentage of pass among students in Upper Basic classes in Enugu state as is evident from analysis of students' results in Basic Education Certificate Examination (BECE). However, the students' academic achievement has not remained satisfactorily stable; neither has it become comparable to the standards found in advanced countries. Although, several factors such as the structural problems in Basic science curriculum arrangement and teaching methods adopted by science teachers have been implicated for the poor academic achievements in the subject, little or no attention has been given to predictive effect social competence and gender on basic science students' achievement in basic science.

Majority of the studies on the relationship between social competence and gender and academic achievement in science subjects at secondary school levels in Nigeria have significantly focused on students at the senior level with evidences of such relationships among students at the junior level being scanty. In light of these issues, the need arises for an empirical investigation into the predictive values of social competence and gender in upper basic science students' academic achievement. Thus, the problem of the study posed as a question therefore is: Does social competence and gender predict upper students' academic achievement in basic science?

Purpose of the Study

The purpose of this study was to investigate social competence and gender as predictors of junior students' academic achievement in Enugu State. Specifically, the study sought to determine the:

1. Amount of variation in Basic science students' achievement scores that is attributed to their social competence.
2. Amount of variation in Basic science students' achievement scores that is attributed to students' gender.
3. Amount of variation in Basic science students' achievement scores that is attributed to both social competence and gender.

Research Questions

1. What is the amount of variation in Basic science students' achievement scores that is attributed to their social competence?

2. What is the amount of variation in Basic science students' achievement scores that is attributed to students' gender?
3. What is the amount of variation in Basic science students' achievement scores that is attributed to both social competence and gender?

Hypotheses

The following null hypotheses were proposed for the study, which was tested at .05 level of significance.

1. Social competence is not a significant predictor of junior secondary school students' academic achievement in Basic Science.
2. Gender is not a significant predictor of junior secondary school students' academic achievement in Basic Science.
3. Social competence and gender do not significantly co-predict junior secondary school students' academic achievement in Basic Science.

Method

The design adopted for the study was predictive correlation. Correlation research design according to Nworgu (2015) attempts to establish relationships between two or more variables and generally cover studies concerned with the relatedness of two or more variables. The correlation design indicates the direction and size of the relationship between the variables and may employ a group of statistics known as regression analysis. The study was carried out in Enugu state. The state shares borders with Abia state and Imo State to the south, Ebonyi state to the East, Benue state to the Northeast, Kogi state to the Northwest and Anambra state to the West. Enugu, the capital city of Enugu state, is approximately two and half driving hours away from Port Harcourt. Enugu Education Zone comprises of three local government areas, namely: Enugu East local government area, Enugu North local government area and Isiuzo local government area. Enugu education is suitable for the study because students' achievement in Basic science in Basic science within the zone has not met the satisfactory standard and expectations of teachers and researcher. The findings of the study may therefore inform educational practices that could improve academic achievement in the state. The population of the study comprises 9,192 junior secondary school two (JSS2) students in Enugu State. The sample for the study consisted of 100 JSS2 students obtained using multi-faceted sampling procedure involving random and purposive sampling techniques. The instrument for data collection was the self-report students' Social competence Scales (SSCS).

> SSCS was a self-report students' version of the Social competence Scales adopted from Trevisan *et al.* (2018). The instrument requires the students to rate themselves on a 5-point likert scale ranging from 'not true or almost never true' to 'very true or almost always true'. Higher scores indicated greater agreement with an item and thus, higher level of social competence. The instrument had 77 items according to content domains of the dimensions and a demographic data

section that was used gather information on students' gender. It has seven dimensions namely: social motivation, social inferencing, empathic concern, social knowledge, verbal conversational skills, non-verbal sending skills and emotion regulation.

The validity of SSCS was done by three lecturers in the department of science education, Nnnamdi Azikiwe University, Awka. The reliability of SSCS was established using Cronbach's Alpha which yielded a coefficient of internal consistency of 0.77. The researcher with the help of 20 research assistants who are subject teachers in the sampled schools administered the instrument directly to the respondents. The researchers briefly oriented the research assistants on the objectives of the study and how to administer the instrument and collect the data. The instruments were administer and collected on the spot to reduce sample mortality. The data generated from the instrument were collated by the researchers and inspected and was used for data analysis. The data for the study was analysed using simple linear and multiple regressions. The criteria for rejecting or not rejecting any null hypothesis which were tested at 0.05 level of significance was that whenever the P-value was less than or equal to 0.05 ($P \leq 0.05$) the null hypothesis was rejected and whenever the Pvalue is greater than 0.05 ($P > 0.05$), the null hypotheses was not rejected.

Results

Research Question 1: How does social competence predict junior secondary school students' academic achievement in Basic Science?

Table 1: Prediction of Junior School Students' Achievement score in Basic Science by Social Competence

Model	R	R^2	Adjusted R^2	Unstandardized coefficients ( )	Std. Error
Constant	.128[a]	.016	.015	85.291	11. 868
Social competence				.093	

a. Predictors: (Constant), Social Competence

Table 1 shows that a positive correlation (R = 0.128) exists between junior secondary school students' social competence and their achievement score in Basic Science. The R-Square value of 0.016 indicates that 1.6percent of the variance in Basic Science scores is predicted by social competence. The unstandardized coefficient of 0.093 shows that a unit rise in social competence increases academic achievement score in Basic science by 0.093.

Hypothesis 1: Social competence is not a significant predictor of junior secondary school students' academic achievement in Basic Science.

Table 2: Significance of Prediction of Achievement score in Basic Science by Social Competence

Model		Sum of Squares	df	Mean Square	F	Pvalue
1	Regression	2325.403	1	2325.403	16.510	$.000^{b}$
	Residual	140564.197	998	140.846		
	Total	142889.600	999			

a. Dependent Variable: Achievement score

b. Predictors: (Constant), Social Competence

Table 2 shows that social competence is a significant predictor of achievement scores in Basic Science, F (1, 998) = 16.510, $p < 0.05$. The null hypothesis was therefore rejected meaning that social competence is a significant predictor of junior secondary school students' academic achievement in Basic Science.

Since social competence is a significant predictor of achievement scores in Basic Science, the regression model (Y= a + bX) for the prediction of achievement score in Basic Science as derived from Table 1, where constant = 85.291 and b value = 0.093 is:

AABS = 85.291 + 0.093(SC)

Where, AABS = Academic Achievement in Basic Science and SC = Social Competence.

Research Question 2: How does gender predict junior secondary school students' academic achievement in Basic Science?

Table 3: Prediction of Junior School Students' Achievement score in Basic Science by Gender

Model	R	R^2	Adjusted R^2	Unstandardized coefficients ( )	Std. Error
Constant	$.103^{a}$	.011	.010	77.653	11.902
Gender				-2.923	

a. Predictors: (Constant), Gender

Table 3 shows that a positive correlation (R = 0.103) exists between junior secondary school students' gender and their achievement score in Basic Science. The R-Square value of 0.011 indicates that 1.1percent of the variance in Basic Science scores is predicted by gender. The unstandardized coefficient of -2.923 shows that in moving from male to female students, academic achievement score in Basic science decreases by 2.923.

Hypothesis 2: Gender is not a significant predictor of junior secondary school students' academic achievement in Basic Science.

Table 4: Significance of Prediction of Achievement score in Basic Science by the Dimensions of Parental Involvement

Model		Sum of Squares	df	Mean Square	F	Pvalue
1	Regression	1512.760	1	1512.760	10.679	.001[b]
	Residual	141376.840	998	141.660		
	Total	142889.600	999			

a. Dependent Variable: Basic Science Achievement
b. Predictors: (Constant), Gender

Table 4 shows that gender is a significant predictor of achievement scores in Basic Science, F (1, 998) = 10.679, $p < 0.05$. The null hypothesis was therefore rejected meaning that gender is a significant predictor of junior secondary school students' academic achievement in Basic Science.

Since gender is a significant predictor of achievement scores in Basic Science, the regression model (Y= a + bX) for the prediction of achievement score in Basic Science as derived from Table 3, where constant = 77.653 and b value = 2.923 is:

AABS = 77.653 + 2.923(GEND)

Where, AABS = Academic Achievement in Basic Science and GEND = Gender.

Research Question 3: How does social competence and gender co-predict junior secondary school students' academic achievement in Basic Science?

Table 5: Co-Prediction of Junior School Students' Achievement score in Basic Science by Social Competence and Gender

Model	R	R^2	Adjusted R^2	Unstandardized coefficients ( )	Std. Error
Constant	.162[a]	.026	.024	90.098	11.813
Social competence				.091	
gender				-2.843	

a. Predictors: (Constant), Social competence, Gender

Table 5 shows that a positive multi-correlation (R = 0.162) among junior secondary school students' social competence, gender and their achievement score in Basic Science. The R-Square value of 0.026 indicates that 2.6percent of the variance in Basic Science scores was co-predicted by social competence and gender. The unstandardized coefficients of 0.091 and -2.843 shows that while social competence increases academic achievement in basic science by 0.091, being a female students results in correspondent decrease in achievement by 2.843

Hypothesis 3: Social competence and gender do not significantly co-predict junior secondary school students' academic achievement in Basic Science.

Table 6: Significance of Prediction of Achievement score in Basic Science by the Dimensions of Parental Involvement

Model		Sum of Squares	df	Mean Square	F	Pvalue
1	Regression	3756.200	2	1878.100	13.458	.000[b]
	Residual	139133.400	997	139.552		
	Total	142889.600	999			

a. Dependent Variable: Basic Science Achievement

b. Predictors: (Constant), Social Competence, Gender

Table 6 shows that social competence and gender are a significant co-predictors of achievement scores in Basic Science, F (2, 997) = 13.458, $p < 0.05$. The null hypothesis was therefore rejected meaning that social competence and gender significantly co-predicted junior secondary school students' academic achievement in Basic Science.

Since social competence and gender are significant co-predictors of achievement scores in Basic Science, the regression model ($Y = a + bX_1 + bX_2$) for the prediction of achievement score in Basic Science as derived from Table 5, where constant = 90.098, b value = 0.091 and c value = -2.843 is:

AABS = 90.098 + 0.091 (SC) - 2.843(GEND)

Where, AABS = Academic Achievement in Basic Science, SC = Social Competence and GEND = Gender.

Discussion

The findings of the study showed that social competence is a significant predictor of academic achievement in basic science. The findings of the study can be hinged on the fact that students who have high level of social competence develop self-awareness which enables them to effectively engage with other students and gain deeper understanding over the learning materials for which they interact. Social competence gives the students the effectiveness needed for greater interpersonal communication helping them in their learning progress. Thus, socially competent students are often sufficiently disposed to foster greater academic relationship with their peers and classmates as well as their teachers. These interactions help them to be at ease when exposing their lack of understanding in order to learn from their fellow peers or to ask questions.

Social competence also plays significant role in facilitating greater academic commitment and engagement in the learning process. Since socially competent students know how to navigate the social environment within academic setting, their interest is easily aroused and sustained in the learning process. This engagement is often enhanced by the introduction of more social activities within the classroom by either calling for role play, individual presentation and focus group discussions or collaborative learning. Since knowledge is not acquired in isolation, the engagement of socially competent students in the learning process affords them the opportunity not only to learn from the teachers but also to learn from the fellow students or their seniors, thus, improving academic achievement.

The findings of the study are in agreement with the findings of Ekpenyong, Adediran and Adeyemi (2019) that social competence is highly correlated with and greatly influenced primary school pupils' academic achievement. The findings of the study support the findings of Shehu (2019) that social competence and attitudes towards school were significant predictors of academic achievement in elementary school students. The findings of the study contradict the findings of Nurfadila (2019) that students' social competence was not a significant predictor of academic achievement in English language.

The findings of the study showed that gender was a significant predictor of academic achievement in Basic science. However, with respect to social competence, male students tend to achieve more than female students in Basic science. The observed variance in academic achievement with respect to gender could be attributed to the inherent gender stereotype common in classrooms. Male students tend to receive more attention and show more interest when the subject matter involves science. This may incite the teacher to focus more on the males or allow the male students dominate the basic science without ensuring that gender equity is met. Thus, socially competent males may interact more among themselves or with other male students over science subjects like basic science and dominate the classroom to the unconscious neglect of the teacher resulting in male having higher academic achievement irrespective of their level of social competence. The findings of the study further showed that social competence and gender together significantly predicted academic achievement in Basic science. The interaction between the variables showed that although male students may perform better than female students in Basic science, high social competency skills could mitigate this gender gap by enable female students to relate properly with other students over their learning and thereby improve academic achievement. The findings of the study are disagree with the findings of Ani, Obodo, Ikwueze and Festus (2021) that there is no significant influence of gender on students' academic achievement in basic science.

Conclusion

Social competence is a significant predictor of academic achievement in Basic science. It plays a significant role in students' academic achievement a gives students the capacity to adapt to the social dynamics of the academic environment, maximize their learning through varying relationships with students and teacher and thereby enhance academic achievement. It is also concluded that gender is a significant factor in junior secondary school students' academic achievement in Basic science. The significance of the co-predictive power of social competence and gender on academic achievement of junior secondary school students in Basic science denotes the fact gender disparities exist in the social competence of students with male students possessing higher social competence.

Recommendations

1. There should be in-depth study into gender disparities in academic achievement of junior secondary school students in basic science with respect to the social dynamics employed by Basic science teachers within the school periphery.
2. Basic science teachers should ensure that the atmosphere within the classroom is gender friendly enough, making sure that both male and female students have a conducive social atmosphere to be actively involved in the learning process.
3. Effort should be made by science teachers to facilitate greater interaction among male and female students especially over learning materials in relation to Basic science. This can be achieved through teacher-directed group studies initiated with a view to mitigate any bias to learning or to address any form of gender-stereotype issues within the classroom.

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EMERGING TECHNOLOGIES FOR TEACHING AND LEARNING OF BASIC SCIENCE EDUCATION PROGRAMME IN THE NEW NORMAL IN TERTIARY INSTITUTIONS IN NIGERIA

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Abstract

Technologies are ubiquitous in the 21st century, and educators need to integrate relevant technologies into their teaching practices to meet expectations and keep abreast with the education profession's advancement. A descriptive survey research design was used in this study. Three research questions and one null hypothesis guided the study. The population of the study comprised all the 24 Integrated Science lecturers (10 males and 14 females) in both private and public tertiary institutions in Enugu State, Nigeria. The population was manageable and as a result no sample was carried out for the study. An instrument titled "Questionnaire on Emerging Technologies in Teaching and Learning" (QETTL). Three experts validated the instrument while the reliability of the instrument was estimated using Cronbach Alpha formula with reliability indices of 0.76. Frequency, percentage, mean and standard deviation were used to answer the research questions while Chi square statistics was used to test the null hypothesis. Findings revealed that some of the challenges hindering Basic Science teachers from utilizing technologies in teaching and learning are lack of internet access and in-service training among others. Based on the findings, it was recommended among others that in-service training of lecturers on the usage of 21st century technologies and provision of internet connectivity should be prioritize by government and the university management to enable lecturers maximize effectively 21st century technologies during teaching and learning.

Keywords: Basic Science, Emerging Technologies, Gender, Learning, New Normal, Teaching.

Introduction

Technology is a transformative tool in teaching and learning. With the teacher's pedagogical practices, it becomes an important tool to ignite interests and enhance the motivational aspects on the learners. In fact, many technological applications are designed to make changes in the delivery of instruction especially in the new normal. Technology plays an immense role in humans' lives, revolutionising many fundamental activities and penetrating most areas, including education (Raja & Nagasubramani, 2018), transforming research activities, scholarship and services to society in the academic field and enhancing teaching and learning (Rana, 2017). Educational technology refers to technology integration into the curriculum, altering the educational process (Cloete, 2017). Students develop new skills and enhance their learning experience through various technology platforms (Lawrence & Tar, 2018).

Technology supplements teaching materials, offering students a new customisable learning experience with a self-paced, problem based, interactive learning environment, improving their knowledge and understanding (Moro et al., 2021). Educational technology improves students' motivation, satisfaction, attitudes, interaction, engagement and academic performance (Akçayır & Akçayır, 2016; Moro et al., 2021; Saltan & Arslan, 2016). The massive changes brought by technological advancement in the scientific field necessitate Basic Science lecturers to embrace technology for effective communication, better teaching aids and to assist students' self-expression (Mohd Yusof & Tahir, 2017). Educational and professional courses acknowledge technology's importance in contemporary teaching (Watty et al., 2016). Basic Science education needs to progress, develop, adopt and advocate for good governance in technology application to accommodate the new trend in the human capital market (Yap et al., 2014). The World Economic Forum (2018) reported several declining occupations due to technology's advancement; any subject curriculum neglecting technology aggravates the situation (Burritt & Christ, 2016). Nevertheless, Basic Science Lecturers welcome the advancement of technology. Taib et al. (2022) noted the high correlation between digitalization with lecturers' technology readiness, yet technological knowledge and usage do not depict the current industrial needs. The shifts in the role of teaching from merely use of traditional methods to innovative and information technology knowledge leads to better decision-making.

Technology integration into Basic Science education is vital because rapid technological growth affects the global economy and changes teachers' roles (Ogundana et al., 2015). Accordingly, the educational setting must efficiently and effectively provide content adapting to these changes (Birt et al., 2018). Moreover, future graduates are entering a technology-rich workplace requiring sufficient digital technology literacy skills to operate efficiently (Ahmad & Mohd Rhouse, 2016). Basic Science lecturers are responsible for shaping future science professionals to bridge the gap between the current issues. The Basic Science curriculum and scientific practice asserted that technology integration into Basic Science education allows students to gain relevant knowledge, skills and abilities.

Lecturers' responsibilities include transferring knowledge and providing guidance and training to students. lecturers are key stakeholders in integrating technology into the education system (Qasim & Kharbat, 2020). The role is poorly executed, causing a disparity between industry demands and graduates' quality. Higher institutions lag in adopting innovative pedagogy and overlook complex skills fostered by technology (Moro et al., 2021). One key reason is lecturers' reluctance to embrace the information age. Studies reveal the unoptimised and minimal integration of lecturers' technology usage (Taib et al., 2022; Lawrence & Tar, 2018; Watty et al., 2016) because lecturers opined the challenges – time constraints, accessibility, and network connection, lack of training and competency, and little technical support – outweigh the benefits (Milutinovic, 2022; Awang et al., 2018). Lecturers are also concerned about losing control over how their students manage tasks with technology integration (Gurjar & Sivo, 2022; Moro et al., 2017). Hence, debate between educational institutions and industry players over educational technology adoption is ongoing due to the gap between employers' expectations and requirements relating to technology competency and the actual skills and abilities of Basic Science graduates. This study describes the 21st century educational technology usage among Basic Science lecturers in their practices through an overview of educational technology usage frequency, tools and platforms used.

Integrating e-learning and other educational technologies affected Basic Science education. Technology application in Basic Science education enables interactive, constructive and independent learning (Delgado et al., 2015), improving classroom activities' effectiveness and student engagement (Dua et al., 2016; Mirzajani et al., 2016). Technologies applicable in Basic Science education are web applications and relevant technology devices used to prepare teaching materials, tests and tutorials and engage with students (Kearney et al., 2017; Khatib, 2016). New experiential learning allows students to better understand, decode and learn the material (Moro et al., 2017). Incorporating technologies into Basic Science education encourage progress and good governance in technology usage and adoption (Asonitou, 2020) for the 21st century educational setting. Technology integration in Basic Science education considers the intersection of content, pedagogical and technological knowledge for effective instruction to achieve learning goals.

Technology integration is introducing modern facilities and various technologies into teaching and learning of different courses. Technology integration eases knowledge transference and encourages creativity, collaborative problem-solving and independent learning. Scholars believe emerging technology improves students' performance, stimulates creativity and innovative thinking, and promotes student engagement (Qasim & Kharbat, 2020; Mohd Yusof & Tahir, 2017; Cheah, 2016). Also, technology integration nurtures students' cognitive processes (Moro et al., 2017). Emerging technology in teaching and learning have identified various instructional technologies (hardware or software) for lecturers' usage (Abu Karsh, 2018).

Technology does not replace pedagogy but rather enhances teaching and learning (Al-Emran & Shaalan, 2015). Watty et al. (2016) suggested using Web 2.0, Web 3.0, cloud computing, tablets and smartphones, games and gamification, learning management systems and massive open online courses (MOOCs). Augmented reality (AR), virtual reality, 3D printing and mobile devices could be key educational technology for learning engagement (Birt et al., 2018; Johnson et al., 2016), facilitating information delivery, collaboration, connection and communication between students, peers and lecturers. Some of the educational technologies for the 21st century classroom with specific examples are tabulated in appendix 1. Technology is evolving; nevertheless, current technology is viable for creating a technology-enhanced learning environment (Moro et al., 2021). Lecturers must holistically prepare students and produce work ready graduates for job market demands (Darling-Aduana & Heinrich, 2018). Researchers have emphasised technological tools and applications provide opportunities and improve education quality and student engagement (Gurjar & Sivo, 2022; Taib et al., 2022; Ilias et al., 2020; Qasim & Kharbat, 2020; Wu et al., 2019; Al-Htaybat et al., 2018; Mavroudi & Tsagari, 2018). The above discussion highlights a symbiotic relationship between 21st century technology and teaching and learning especially in Basic Science education. Technology adoption and integration are inevitably essential, and the role of lecturers are crucial irrespective of gender.

Gender is the role assigned to males and females by the society. Gender is a personality trait, attitude, behavioural values, relative power, influence, roles and expectations that the society ascribes to the two sexes (Eze, 2013). gender is inculcated through norms, morals, training, orientation and indoctrination in the society. The difference in training, orientation and indoctrination and likes result to differences in the way male and female students learn. According to Cornell (2003), female students are statically learning inclined that is expected as static. Concrete and visual instructional materials are enjoyed by by and effective with boys; such as moveable clocks, protractors, thermometer that ensure some hands-on-activity (Cornell, 2003; Obodo & Ani, 2022). based on the assertions the researchers want to find out whether or not Basic Science lecturers usage of 21st century technologies is dependent on gender. Both male and female Basic Science lecturers may face some challenges in the usage of the 21st century technologies. Hence the study also investigated such challenges.

The challenges face by Basic Science lecturers in the usage of 21st century educational technologies are of interest to the researchers. These challenges if found and addressed could promote the usage of 21st century educational technologies in the new normal among the Basic Science lecturers. Basic Science lecturers teach students who will in turn teach sciences at primary and secondary school levels. So if this set of teachers are use 21st century technologies to teach sciences, it will not only make the teaching and learning of sciences interesting, curiosity provoking and meaningful but also inculcate the skills of the use of 21st century educational technologies to the would be teachers, hence, the need for this study. This study therefore, sought to determine the 21st century technologies used by Basic Science lecturers in teaching and learning of Basic Science education programme in the new normal in tertiary institutions in Enugu State, Nigeria. Specifically, the study determined the:

i. The 21st century technologies used among Basic Science lecturers in both private and public tertiary institutions in Enugu State, Nigeria.

ii. Challenges encountered by Basic Science lecturers in the utilization of 21^{st} century educational technologies in teaching and learning in the new normal.
iii. Influence of gender on 21^{st} century educational technologies usage among Basic Science lecturers in both private and public tertiary institutions in Enugu State, Nigeria.

Research Questions

The following three research questions guided this study:

1. How frequently do Basic Science lecturers use the 21st century educational technologies in teaching and learning process?
2. What are the challenges encountered by Basic Science lecturers in the use of 21^{st} century educational technologies?
3. What is the influence of gender on 21^{st} century technologies usage among Basic Science lecturers in tertiary institutions in Enugu State, Nigeria?

Method

Descriptive survey research design was employed in this study. Three research questions and one null hypothesis guided the study. The population of the study comprised all the 24 Integrated Science lecturers (10 males and 14 females) in both private and public tertiary institutions in Enugu State, Nigeria. The population was manageable and as a result no sample was carried out for the study. The selected Basic Science lecturers possessed the highest integrated Science qualification and experience in teaching and learning of Basic Science subjects regardless of position grade, terms of appointment, specific university establishment and location; lecturers teaching non-science subjects were excluded to avoid deviation from the Basic Sciences' perceptions and definitions. All the 24 Basic Science lecturers were selected and used for the study. Science lecturers with experience using any of the 21st century educational technologies were eligible to participate; lecturers without the relevant experience were excluded. An instrument titled "Questionnaire on Emerging Technologies in Teaching and Learning" (QETTL). The questionnaire used for the study consisted of two sections. Section A recorded demographic information, and Section B was sub-divided into two clusters, namely Cluster I and II. Cluster I was structured on two point scale of "Used" (U=2) and "Not Used" (NU=1). Cluster II deals with the challenges faced by Basic Science lecturers in the use of 21^{st} century educational technologies. Cluster II was structured on four-point Likert type scale of: Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (SD). The instrument was face validated using two experts in Educational Technology and one expert in Measurement and Evaluation, all in Enugu State University of Science and Technology, Enugu. The reliability of the instrument was done in two parts. For Cluster I which is dichotomously scored, Kudder-Richardson, 20(KR-20) was used, while Cluster II which is non-dichomously scored, Cronbach's alpha was used. The reliability estimates of 0.82 and 0.76 were arrived at for Clusters I and II respectively. The researchers and two research assistants distributed the instrument to the Basic Science lectures and their responses were collected on the spot and used for the study. Appendix 2 contains the respondents' demographics. Frequency and percentage were used to answer research question one while mean and standard deviation were used to answer research question two. Chi square statistics was used to test the null hypothesis.

Results

Table 1 presents the results of the demographic analysis. The majority were female, with 30 respondents (66.6%) and 15 male respondents (33.3%). Most respondents were between 41 and 50 years old (35.6%), followed by 31 and 40 years old (20.0%), followed by 51 and 60 years old (15.5%), 11.1% aged 24 and 30 years old & 61 and 70 years old respectively and 16.4% aged 50 years and above. About 55.6% of the respondents have a doctorate, 33.3% have a master's degree, 11.1% have bachelor's degree and 0% have a professional qualification. Almost quarter (24.4%) were senior lecturers, followed by lecturers I (17.7%), lecturers II (15.5%), professors (13.3%), associate professors (11.1%). Assistant lecturers and graduate assistant lecturers have a similar percentage (8.9%). Approximately 48.8% of respondents have served for less than 20 years, 26.6% for less than 25 years, and 11.1% for 26 to 30 years, 13.3% of respondents have more than 30 years of working experience.

Table1: Demographic profile of the respondents (N = 24)

S/N	**Demographic Profile**		**Frequency**	**Percentage**
1	**Gender**	**Male**	**10**	**33.3%**
		Female	**14**	**66.6%**
2	Age	24–30 years Old	03	**11.1%**
		31–40 years Old	05	**20.0%**
		41–50 years Old	07	**35.6%**
		51–60 years Old	04	**15.5%**
		61–70 years 0ld	03	**11.1%**
		Above 70 years	**02**	**6.7%**
3	Highest education level	Doctorate (PhD)	**16**	**55.6%**
		Master's degree	**05**	**33.3%**
		Bachelors degree	**03**	**11.1%**
		Professional qualification (e.g.,NCE, TCII)	**0**	**0%**
4	Current academic appointment	Professor	**04**	**13.3%**
		Associate Professor	**03**	**11.1%**
		Senior lecturer	**04**	**24.4%**
		Lecturer I	**04**	17.7%
		Lecturer II	**05**	**15.5%**
		Assistant Lecturer	**02**	**8.9%**
		Graduate Assistant Lecturer	**02**	**8.9%**
5	Working	5 years and below	04	**8.9%**

	experience as a lecturer (years)	6–10 years	06	**13.3%**
		11–15 years	10	**22.2%**
		16–20 years	02	**4.4%**
		21–25 years	12	**26.6%**
		26–30 years	**05**	**11.1%**
		Above 30 years	**06**	**13.3%**
	Teaching hours spent per week	3 hours and below	07	15.5%
		4–9 hours	12	26.6%
		10–15 hours	10	22.2%
		16–20 hours	09	20.0%
		Above 20 hours	07	15.5%

Most of the respondents (26.6%) spent about 4 to 9 hours a week on teaching activities, and 20.0% spent around 10 to 15 hours a week on teaching activities while 20.0% of respondents spent 16 to 20 hours and 15.5% of respondents spent 3 hours below and 20 hour above respectively.

Table 2: Respondents' Educational Technology Usage Profiles (N = 45)

S/N	**Cluster Statement**		**Frequency**	**%**
1	Usage frequency in teaching and learning	Rarely used		**s**
		Occasionally used		
		Frequently used		
		Use almost always		
		Use all the time		
2	Educational technology tools	Smartphone	07	
		Tablet	10	
		Laptop	12	
		Desktop computer	09	
		LCD projector	08	
		Interactive whiteboard	10	
		Smart television		
		Camera video device		
		Sound device		
		Software and applications		
		Others		
3	Educational technology platforms	Learning management system (LMS)		
		Social media or collaborative technologies		
		Communication		
		Simulated learning systems		
		Learning styles or approach concepts		
		Mobile technologies		
		Assessment or evaluation technologies		
		Presentation and learning resource creation tools		
		Learning objects or resources		
		Common accounting tools		

Table 2 summarizes the respondents' educational technology usage of the 21st century technologies listed in Table 2. About 34.9% of respondents admitted using educational technology in their teaching activities all the time; 3.1% rarely use it. Laptops, desktop computers and LCD projectors were the most used technological devices. Tablets, camera video devices, sound devices, software and applications were seldom used. Smart televisions and interactive whiteboards were least used. As for the technological platforms, most respondents (70.3%) used LMSs, followed by communication platforms (68.2%) and mobile technologies (50.8%). Only 7.7% of respondents simulated the learning system for their classroom strategies. Other technology platforms (learning styles or approach concepts; mobile technologies; assessment or evaluation technologies; presentation and learning resource creation tools; learning objects or resources; common accounting tools) show less and average usage.

Discussion of the Findings

This study investigated 21st century technology usage in Basic Science educators' practices. The findings describe their pattern of educational technology usage frequency, tools and platforms used. The following subsections describe this pattern's theme and elaborate on the quantitative analysis result.

Usage frequency of 21st century educational technology

Table 5 describes accounting educators' usage frequency of 21st century educational technologies in Table 3 (either rarely, occasionally, frequently, almost always, all the time) in the classroom. About 34.9% of respondents fully integrated technologies into their practices; 26.2% used them frequently. Meanwhile, 25.6% used them almost always, 10.3% occasionally and 3.1% rarely. Educators must embrace educational technology because technology significantly impacts people's lives and activities (Abu Karsh, 2018; Ahmad & Mohd-Rhouse, 2016). With more comprehensive technological advancements available, the usage frequency should be higher (Allison, 2022). Efforts were noted but they were insufficient for instilling the maximum learning experience for students' skills development.

Educational technology tools used

The findings suggest that accounting educators mostly use desktop computers (77.4%), LCD projectors (78.5%) and laptops (79.5%), similar to the findings of Ahadiat (2008) and Goksun et al. (2018). The findings of our study conducted in 2020 projected a similar pattern to previous studies. The technology tools' high usage could be due to familiarity, as some have been used since the 1990s and are Kunjappan et al., 2016). However, our findings reveal widespread usage of smartphones in teaching and learning (65.6%). Several scholars (Lawrence & Tar, 2018; Taib et al., 2022) mentioned that while many educators embraced technology in their practice, they disregarded other 21st century educational technologies; for instance, interactive whiteboards and smart televisions might be mostly unavailable in education institutions due to their high cost and training requirement. The unavailability of facilities and infrastructure was potentially the main challenge and barrier to teaching using technology (Abdullah et al., 2016; Ghavifekr, Abd Razak et al., 2014). Hindering factors such as the lack of classroom facilities, cost, technological competency and unfamiliarity with current technology deter educators from changing and disrupt the integration that could enhance educators' effectiveness and interactive pedagogy (Alshmrany & Wilkinson, 2017; Dua et al., 2016).

Educational technology platforms used

The findings show that the most used platforms by accounting educators were LMSs (70.3%), communication (68.2%) and social media or collaborative technologies (52.3%). Blankley et al. (2018) corroborated that accounting educators naturally use LMSs. The faculty or institution usually provided the platform, hence, the familiarity or obligation to use it. Although LMSs support the teaching process, their functions are limited to paperless work (Blankley et al., 2018), which is insufficient for instilling technological skills among students as demanded by IR4.0. Likewise, the findings indicate educators' minimal usage of the flipped classroom learning approach, gamification (e.g., Padlet, Kahoot, Socrative, Nearpod) and blended learning; they create game-based activities and animations to help students learn (Watty et al., 2016). Several researchers highlighted critical infrastructure, facilities and support for educators to embrace educational technology (Abu Karsh, 2018; Alshmrany & Wilkinson, 2017; Gordon et al., 2018). Other factors were educators' attitudes, knowledge, skills and technology capabilities (Scherer et al., 2019; Weng et al., 2018). Educational institutions and the government's strategic approach, training and support could result in the integration of 21st century educational technology platforms into education.

Conclusion

Technology nowadays is inevitable. Its application is ubiquitous across sectors, including education, and continuously evolving; thus, accounting educators must proactively embrace 21st century technology in their practices. The numerous tools and technology platforms and industry demands necessitate educators to embrace technologies to equip graduates with technological skills and knowledge. Consequently, educational institutions must create a technology-integrated environment that motivates educators to use interactive 21st century educational technology in their classrooms. They must adopt various contemporary educational technologies to facilitate interactive teaching pedagogy and enhance students' learning experiences. Furthermore, the findings reveal technology characteristics, organisational factors and individual factors significantly influence Basic Science educators' usage behaviour towards 21st century educational technology. The findings provide invaluable insight into Basic Science educators' uses of technology in their practices. Educators are crucial in demonstrating the effectiveness of technology integration in preparing future graduates that embrace the profession's volatility, uncertainty, complexity, and ambiguity. Therefore, teachers and school management responsible for the Basic Science curriculum should consider initiatives to exploit and maximise 21st century educational technology use in instructional design.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Future research should be explore the impact of COVID-19, at least after 3 years, to examine the probable changes in technology adoption. Further, researchers could also increase the sample size for both quantitative and qualitative measures to draw solid and rigorous conclusions.
2. The findings reflect 21st century educational technology usage; therefore, another possibility is for future research to explore the influence of individual factors on this phenomenon.
3. Future studies could utilise the proposed model for empirical testing to validate the model and discover more concrete findings.

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Appendix 1: 21st Century Educational Technologies Used in Teaching and Learning

S/N	21st century Educational technologies	Example
1	Learning management systems (LMSs)	Moodle; Blackboard; Desire2Learn; iLearn System; MOOCs; iFolio; Claroline; MyGuru2; Learning Care; Learning Cube; Blackboard; MyLMS
2	Learning styles or approach concept	Flipped Classroom; Gamification; Padlet; Nearpod; Kahoot! Socrative; blended learning; mobile learning; distance or online learning, Peardeck
3	Social media or collaborative technologies	Blogs; Wikis; Twitter; Facebook; Instagram; YouTube; Google Drive; Dropbox; Vimeo; Metacafe
4	Communication	Asynchronous (e.g., online discussion board; email; WhatsApp; WeChat; Telegram) Synchronous (e.g., Skype; Google Chat; Adobe Connect; Bloomz; Remind; Sli.do)
5	Simulated learning systems	The Normalised Game; Legends of Learning; Classcraft; SiLAS Solutions; CodaQuest; Animoto, Legends of Learning
6	Mobile technology	Tablet computer; smartphones; mobile apps (e.g., iOS, Android)
7	Technology assessment or evaluation	Quizlet; Quizlet live; Google Classroom; Quizizz; Formative; MOOCs; ZipGrade; Flipgrid; Scan Attendance Manager; Plickers; Kahoot!; Write to Pdf; Google Spreadsheet; Google Form; ClassDojo
8	Presentation and learning resource creation tools	*Software* (e.g., Adobe Presenter; voice recognition software; Microsoft PowerPoint; Google Slide; Book creator; Adobe Captivate; screen capture, i.e., Jing, Camtasia; Prezi; Powtoon; Padlet; Nearpod; Google Slides; Canva; PiktoChart; Adobe Acrobat Reader; Showbie; Plotagon Education) *Hardware* (e.g., drawing tablet, i.e., Wacom; microphones; In class Document Reader; smartphones
8	Learning objects or resources	eBooks; lecture notes or slides; narrated PowerPoint slides; podcast, i.e., audio & video; video lectures; instructional videos; automated video drawings; Flickr; Google Photos; Photobucket; Google Drives; QR code scanner

BIOLOGY TEACHERS' ACADEMIC SELF-CONCEPT AND ACADEMIC STRESS AS PREDICTORS OF ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL BIOLOGY STUDENTS IN ENUGU EDUCATION ZONE

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Abstract

This study focused on teachers' academic self-concept and academic stress as predictors of academic achievement of Biology students' in Enugu Education Zone. Six (6) null hypotheses were postulated for the study. The study adopted ex-post-facto research design. The population of study comprised 74 Biology teachers in 33 public secondary schools in Enugu Education Zone with SS 2 biology students' population of 4,737. The sample consisted of all the Biology teachers' in the Zone and a sample of 10% of the students' were sampled from the Biology teachers' classroom.The instrument used for data collection were three (3) – Marsh teachers' academic self-concept scale, Balamurugau and Kumaran academic stress scale and Students' scores from their promotion examination 2022/2023 academic year were used to measure their academic achievement in Biology. The instruments were validated by three experts and the internal consistency reliability was determined though Cronbach Alpha method. The teachers' self-concept scale yielded a reliability index of 0.92 while teachers' academic stress scale yielded an index of 0.88 coefficients. The data collected were analysed using Simple and multiple regression analysis with Statistical Package for Social Sciences (SPSS) version 22. The findings of the study showed that: Teacher academic self-concept significantly and positively predicted students' academic achievement in Biology in Enugu Education Zone; likewise, teachers' academic stress significantly and negatively predicted students' academic achievement in Biology in Enugu Education Zone. Based on these findings it was recommended amongst others that Biology teachers should arrange learning activities, in such a way that it will help students to be self-directed in their learning in order to have significantly positive achievement in Biology.

Keywords and Phrases: *Biology, Academic Stress, Self-Concept, Academic Achievement, Gender*

Introduction

Biology is one of the core science subjects that are offered by students at senior secondary school level of education. One of the prerequisite subjects for science-based courses at the post-secondary level of education in Nigeria is Biology. Originating from the Greek terms "bios" (life) and "logos" (study), the word biology was born. Thus, the study of life or the study of plants and animals can be termed Biology (Michael, 2015). Biology is a distinct branch of science that examines living things and their basic functions. Biology is a branch of science that examines living things and is designed to provide students with the necessary scientific knowledge and abilities (Michael, 2015). One of the scientific subjects that is well-liked by students studying pure science and has a significant role in the secondary school curriculum is Biology. The goal of the secondary biology curriculum is to equip students with sufficient laboratory and field skills, relevant and useful biology knowledge, and the capacity to use scientific literacy and knowledge to make successful life adjustments (FME, 2018). Learning Biology will equip students with relevant laboratory and field skills, significant and applicable biological knowledge, scientific knowledge useful in health, agriculture, and other personal and community daily life matters, as well as the advancement of functional scientific attitudes, according to the National Policy on Education (NPE, 2013). Biology supports the study of nature. It is strongly related to other science courses including Agricultural science, Chemistry, Geography, Mathematics, and Physics.

Biology as a subject of significant importance plays vital role in any given society and man’s daily life. Considering its various branches and broad applications in different fields, its significance in a nation‘s economic development cannot be over-emphasized. Knowledge of Biology helps us to understand the living world and the ways its many species function evolve and interact. It is a subject matter of great importance and concern to all. Biology helps to develop attitudes and science process skills such as observing, inferring, classifying, hypothesizing, questioning, measuring, interpreting, communicating and predicting (Aisha, 2021). Biology deals with all the physiochemical aspects of life. It encompasses diverse fields including zoology, botany, ecology, genetics, morphology, anatomy, physiology, histology, microbiology, biochemistry, evolution and the more advanced cell biology, molecular biology, among others (Joshi et al 2023). Biology has many applications in the natural environment. Studying biology however allows health care workers to understand the living systems of the body and to apply the knowledge in direct ways to recover and maintain the physical health of both animal and human patients. Biology plays an important role in the understanding of complex forms of life involving humans, animals and plants. Biology helps individuals to understand the interaction between humanity and the world. It also develops interests in the lives of living organisms in an effort to preserve them. Studying biology is the foundation of all characteristics of life on earth. Apart from creating solutions to the numerous challenges of many living organisms, it paves way for inventions and discoveries that improve the quality of life. Biology can also be appreciated by the advances in the improvement of food supply and elimination of hereditary diseases.

Biology being a science-oriented course has developed advancement as it concerns the field of forensic science, genetic engineering and machines (Florence, 2022). Oyovwi (2022) noted that biological knowledge and explosion has expanded all over the world via the internet, hence there are advances recorded in fields such as Biochemistry, Physiology, Ecology, Genetics and Molecular Biology that have made the subject a central focus in most human activities including problems like food scarcity, pollution, population, radiation, disease, health, hygiene, family life, management and conservation of natural resources as well as biotechnology and ethics. Educating people in biology has been widely acknowledged as a way of promoting economic development, eliminating poverty, creating employment and introducing social welfare (Oyovwi, 2022). Oyovwi (2022) further asserted that Biology is a popular science subject taught at the senior secondary level and it attracts the greatest patronage of both Science and Arts oriented students. Despite the relevance of Biology and the fact that it is one of the core subjects recommended by the Federal Republic of Nigeria (FRN, 2014) in the National Policy on Education, there has been a problem of poor achievement among secondary school students (Efobi &Okigbo, 2022). Bamigbade et al, (2021) also posited that although many African countries are making effort at improving Biology at all levels of the educational system, it appears that the returns in terms of students learning achievement are little.

Despite the high place of Biology towards the advancement of national development, students' achievement in Biology remains so abysmal. Achievement in academics is the process of evaluating educational outputs and outputs that are expressed in terms of learning. It is the modification in behaviors, knowledge, skills and attitudes of individuals as a result of their encounter within the schools' system. Academic achievement according to Zheng and Mustappha (2022) is the successful completion of certain educational levels that students can achieve after series of trainings usually within a school, college or university settings. Academic achievement is typically measured by internal or external assessments and refers to the extent to which a student, instructor, or institution has precisely met or fulfilled their long- or short-term educational goals. Academic achievement, according to Suleiman (2023), is the performance results that show how far a person has come toward particular objectives of activities inside instructional environments, like school. Academic achievement can be understood as the knowledge and skills acquired in school subjects, with test scores determining its level. Oyovwi (2022) further defined academic achievement as the outcome of learning that expresses the degree to which instructional objectives have been attained. Hemwati and Ritu (2014) similarly described academic achievement as the level of proficiency obtained in particular literary or academic topic areas. Academic achievement was also described by Steinmayr et al. (2020) as the progress made toward acquiring educational skills and knowledge across a range of disciplines. According to Steinmayr et al. (2020), achievement in academic settings refers to the accomplishment outcomes that show how well a student has used particular ideas that served as the main focus of activities in a learning environment. Hemwati and Ritu (2014) further asserted that the most widely utilized indicators of a student's degree of academic achievement in a given topic are their academic or educational age and accomplishment outcomes. Continuous assessments and class exams are typically used to measure academic accomplishment, which is primarily used to check the extent of students' knowledge, skills, and understanding in relevant areas (Efobi & Okigbo, 2022). Academic achievement, according to Onah (2023), is a student's current standing in terms of their academic performance, as demonstrated by their grades, their performance on instructional achievement tests, and cumulative indicators like degrees and certificates. Numerous variables have been shown to impact Biology students' academic performance, and these variables significantly impact biology students' achievement levels. Studies conducted over time have shown that students who enroll in Biology do not always fare well academically (Akande et al 2018; Duyilemi & Bolajoko, 2014; Joda, 2019). It is so daunting that candidates academic achievement in Biology for the past seven (7) years; 2016 to 2022 are 45.4%, 48.2%, 56.17%, 57.42%, 61.68%, 55.57% and 55.10% respectively (WAEC Chief Examiners report, 2016 to 2022). The students' achievement according to the chief examiners report fell below average in 2016 and 2017. From 2018 to 2022, student performance improved above average, reaching a peak percentage of 61.68% in 2020. Even if there has been a noticeable improvement, Nigeria, a nation in dire need of scientific understanding in fields like Biology, is not entirely encouraged by this development. Agaba (2013) blamed Biology educator's lack of dedication to teaching for the pupils' appalling results. The researcher argued that Biology teachers' self-concept and stress contributed to students' failure. The purpose of this study was to investigate how teachers' academic self-concept and stress affect secondary school Biology students' academic progress.

The term self-concept generally means the way an individual perceives oneself. Self-concept according to Muhammad and Mariam, (2018), is a person's understanding and attitude toward oneself. It is a person's sense of self and the way in which he manifests his abilities and potentials. According to Wehrle and Fasbender (2018), a person's self-concept is the culmination of their valued self-judgments, ideologies and sophisticated ordered system of beliefs. Self-concept is very important and plays a big role in determining a person's personality. When individuals regard their own academic achievements like success, or have navigated difficult subject areas is known as academic self-concept.

Academic self-concept generally is referred to the way individuals view their academic accomplishments. Academic Self-concept according to Onah (2023) is the presumption and evaluation of a person's academic abilities. Onah (2023) further asserted that academic self-concept is the intellectual abilities and personalities of an individual. In general, the term "self-concept" refers to the intricate, coordinated, and self-driven framework of beliefs, perspectives, and judgments that people accept as realistically true in relation to their own existence and the evaluation of their own academic aptitude. The definition of a teacher's self-concept is simply their perception of themselves as educators. According to Onah (2023), an educator's academic self-concept is their self-assertion of their academic skills and their capacity for successful teaching and learning. In the same vein, Ajmal and Rafique (2018) also defined teachers' academic self-concept as how a teacher feels about him/herself as a teacher and how he/she plays his/her role in the school settings through conceptualized pupils' awareness and perception of their academic capacities. According to Jelena and Jelena (2018), teachers' perceptions of themselves are shaped by a number of factors, such as their social self-concept, their effectiveness, and their confidence. As stated by Kumari and Chamundeswari (2013), academic self-concept devises a great influence on the students' academic performance and it helps in determining the level of proficiency among them. Kumari and Chamundeswari (2013) equally noted that the way students conduct themselves at school depends on their self-awareness and their approach regarding their talents and latent potentials. Individuals get better grades in school through their teachers' self-concept when positively impacted. Glotova and Wilhelm (2013) also observed that positive self-concept in teachers encourages student's self-regulation, motivation and a high level of self- esteem. Self-concept in the article is anchored on M. V. Covington's theory of Self-worth which demonstrates how individuals value and present themselves for learning. Self-concept is essential in any teaching–learning process, but, it could be adversely affected by academic stress (ÓscarGavín-Chocano et al. 2021). The World Health Organization (WHO, 25/08/2023) defines stress as a condition of mental strain or uncertainty brought on by a difficult circumstance. According to Osagie (2018), stress is the body's typical reaction to an overwhelming amount of mental, emotional, or physical strain that is too much for a person to handle. The American Psychological Association (APA, 04/10/2023) asserted that stress is a normal reaction to everyday pressure but can become unhealthy when it affects one from functioning effectively. They further stated that stress affects both psychological and physical health invariably reducing the quality of life. Stress occurs when individuals encounter situations that they regard as overwhelming and cannot contend with (Bataineh, 2013). Furthermore, Kahn et al (2013) posited that stress can happen to anyone and it can adversely affect an individual's physical, emotional health and even academic success if it is not properly managed. Stress has become an important topic of discussion among various researchers (Nwakile et al, 2020). Researchers in various fields of education and social sciences have carried out several researches on stress and its dire consequences and established that extensive research on stress is needed in their respective fields (Cîrligeanu, 2017; Osagie, 2018; Alson 2019). Stress can impede academic growth. When the body's response to academic related demand exceeds the adaptive capabilities of that individual is known as academic stress. García-Martínezet al (2021), defined academic stress as the state of distress perceived by individuals as a result of their interrelation with all the external factors that affect purely their academics. Academic stress is referred to as intellectual demands that are known to exceed teachers' or students' internal or external coping resources (Walburg, 2014). Academic stress according to Internet Public Library (IPL, 16/08/2023) is mental worry or frustration that is associated with academic failure. Stress related to academics results from rising demands on the teaching and learning process. Teacher stress is the term used to describe the tension that instructors experience when carrying out their tasks. The concept of stress in this regard is anchored in Richard Lazarus's transactional theory of stress and coping. It shows how the teacher could manage stress through presentation of appealing materials. However, by practicing stress management skills and using appropriate coping mechanisms, teachers may maintain their mental health and lead better lives (Samson-Akpan et al., 2017). Everyone is affected by stress, regardless of gender.

Gender is the psychological, physical, social and cultural characteristics that distinguish males and females (Onah, 2022). The World Health Organization (WHO) defines gender as the socially constructed traits associated with males, women, girls, and boys. This encompasses interactions between people as well as the standards, actions, and roles that come with being a woman, man, boy, or girl. Differently impacted by the various types of stress in academic contexts, male and female teachers eventually experience differing effects on their performance (Wandera, 2021). This research therefore was undertaken on the basis of gender-related differences on teachers' educational self-concept and stress as predictors of academic achievement in secondary school Biology students.

Statement of the Problem

There is an increasing public worry of students' poor academic achievement in Biology in our secondary school system. This disheartening development extends to subordinate schools in Enugu Education Zone of Enugu State. This was made evident in the literature of the zone and has resulted to inability of students to cope effectively with higher educational task when offered admission into the tertiary institutions. Many factors may be responsible for this situation. However teachers' self-concept and academic stress as predictors of students' achievement has remained a silent issue in Enugu Education Zone and these factors are presumed to account for poor academic levels in Biology. Self-concept is the intellectual abilities and personalities of an individual that contributes to how well he does task or not.

Under normal circumstances, teachers should teach students and feel free with the job without much stress. Their major concern should be to prepare and deliver their lessons, go back to their homes and have their rest after the day's activities. However, things do not work out this way because they are not only engaged with school activities but also with other personal activities which invariable leads to stress.

While some researchers have found that teacher and school-related characteristics may be predictive of biology students' achievement, there is no empirical research on teachers' academic stress and self-concept in the Enugu Education Zone of Enugu State. Therefore, the researcher set out to ascertain the extent to which public secondary school Biology pupils in the Enugu Education Zone of Enugu State's academic accomplishment is predicted by their teacher's academic self-concept and academic stress.

Purpose of the Study

The primary goal of the research was to ascertain how public school biology students' achievement in the Enugu Education Zone of Enugu State is impacted by their teachers' academic self-concept and stress. The study specifically aimed to test the:

1. Predictive power of teachers' academic self-concept on students' achievement in biology.
2. Predictive power of teachers' academic stress on students' achievement in biology.
3. The joint predictive indicator of Biology teachers' academic self-concept and stress on Biology students' achievement.
4. Moderating effect of teachers' gender on their academic self-concept in predicting Biology students' achievement.
5. Moderating effect of teachers' gender on their academic stress in predicting Biology students' achievement.
6. Moderating effect of teachers' gender on the combined academic self-concept and stress in predicting Biology students' achievement.

Hypotheses

The following null hypotheses were formulated for the study and tested at 0.05 level of significance:

HO_1: There is no significant contribution of teachers' academic self-concept to the prediction of students' achievement in Biology.

HO_2: There is no significant contribution of teachers' academic stress to the prediction of students' achievement in Biology.

HO_3: The joint contribution of teachers' self-concept and academic stress are insignificant to the prediction students' achievement in Biology.

HO_4: The moderating influence of gender on teachers' self-concept in predicting students' achievement in Biology is insignificant.

HO_5: The moderating influence of gender on teachers' academic stress in predicting students' achievement in Biology is insignificant.

HO_6: The moderating influence of gender on combined teachers' academic self-concept and academic stress in predicting students' achievement in Biology is insignificant.

Method

The study used an ex-post-facto research design that included correlation. Since the ex-post facto research design does not change any independent variables, it was chosen despite the fact that the condition of the teachers and the outcomes were already known (Sharma, 2019). By using correlational statistics, the correlational thread allowed the researcher to ascertain the link between the variables. This design is thought suitable for research projects like this one. The study was conducted in the Enugu Education Zone of Enugu State. Three local governments make up the Enugu Education Zone: the Isi-uzo Local Government Area, the Enugu–North Local Government, and the Enugu

East Local Government. Along with numerous private secondary schools and a few post-secondary establishments, the zone is home to 33 state secondary schools. The area is an urban/rural area. The occupants of the area are mainly public servants, traders, artisans and farmers. The researcher chose Enugu Education Zone because it houses qualified teachers but gets negative return on students' achievement. This was evident in the literature because they performed poorly in their external examinations. Consequently, this research will help the Biology teachers to combine non cognitive teaching variables in their classroom instructions which in turn intend to enhance good speculative achievement of the students. The population of the study was made up of all 74 biology teachers which consist of 14 male teachers and 60 female educators in the 33 public secondary schools in the zone. There are total students population of 4,737 Biology students which consist of 1805 male students and 2932 female students as recorded by (Post – Primary Schools Management Board Enugu, September 4, 2023). The entire population made up the sample size. This is due to the fact that the population is small and manageable. Hence, there was no sampling. While 10% of the students' population were sampled from the Biology teachers' classroom using simple random sampling techniques. The instrument used in collecting the relevant data was three. They are:

1. Marsh teachers' academic self-concept scale modified by the researcher, 2. Balamurugau and Kumaran academic stress scale modified by the researcher and 3. Students' scores from their unified promotion examination 2022/2023 academic year were used to measure their academic achievement in Biology. A well-structured questionnaire titled, Teachers Speculative Self Concept, Academic Stress and Students Academic Achievement Questionnaire was used. The instruments were adapted by the researcher, teachers' self-concept has a four (4) point scale using real number limit. The four-point scale stood used to answer all the research questions in the questionnaire as shown below. The items were scored on positive and negative cue statements. For positive statement, SA and Exactly true takes 4 points and 5 points respectively and reverse for the negative cue statements. The research questionnaire has two (2) sections A and B. Section A dealt with Personal Data of respondents, while Section B dealt with two (2) cluster of twenty-two (22) and twenty (20) sample questions for self-concept and stress respectively. Face-validity was tested in this study. Three experts received the customized instrument: two experts in Science Education from Enugu State University of Science and Technology (ESUT) and one expert in measurement and evaluation from Alex Ekwueme Federal University, Ikwo. The appropriateness, relevance, and suitability of the items in the instrument were assessed by the experts. Their observations, criticisms and corrections led to the modification of the instrument that will elicit the desired information. A trial testing of the instrument was carried out to determine its reliability. The instrument was distributed to twenty (20) respondents comprising Biology teachers in Enugu South LGA of Enugu State. Enugu South was used to determine the reliability because it had the

category of the sampled population under consideration and also, the region wasn't designated for the investigation. Using Cronbach Alpha statistics, the reliability coefficients of the instruments were ascertained. The reason for choosing this was that the items' scores were not binary. The teachers' self-concept scale yielded a reliability index of 0.92 while teachers' academic stress scale yielded an index of 0.88 coefficients. The overall reliability index was obtained at 0.86. This shows that the instruments are reliable and fit for data collection. Two (2) research assistants that the researcher hired helped with the dissemination and retrieval of the questionnaire. The analysis of the data was done using the Statistical Package for Social Sciences (SPSS) version 22. Simple and moderated regression analysis was used to analyse the data. The null hypothesis was tested at a significant level of 0.05; if the p-value is less than this threshold, the null hypothesis should be rejected; if not, it should not be.

Results

The results were presented in the table below according to the null hypotheses that guided the study. Table 1 shows the un-standardized coefficients with t- and p- values of each predictor and the moderator variables respectively. The table showed that each of the independent variables made a significant contribution to the prediction of academic achievement.

Table 1: ***Relative Contribution of Teachers' Academic Self-Concept and Academic Stress to the prediction of the Academic Achievement of Secondary School Biology Students***

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**	**95.0% Confidence Interval for B**	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	52.796	4.917		10.739	.000	42.991	62.602
	Self-concept	.248	.052	.453	4.745	.000	.143	.352
	Stress	-.205	.053	-.371	-3.906	.000	-.310	-.100
	Gender	.276	1.274	.021	.217	.829	-2.264	2.817
2	(Constant)	15.730	24.848		.633	.529	-33.867	65.327
	Self-concept	1.208	.403	2.209	3.000	.004	.404	2.012
	Stress	.225	.377	.407	.597	.552	-.527	.976
	Gender	.191	11.235	.014	.017	.986	-22.234	22.616
	Self-concept*stress	-.012	.006	-1.672	-1.962	.054	-.024	.000
	Gender*Self-Concept	-.132	.126	-.689	-1.048	.298	-.383	.119
	Gender*Stress	.103	.140	.608	.737	.464	-.177	.383
3	(Constant)	161.350	80.145		2.013	.048	1.336	321.364
	Self-Concept	-1.754	1.602	-3.207	-1.095	.278	-4.953	1.445

Stress	-2.280	1.364	-4.124	-1.671	.099	-5.004	.444
Gender	-81.961	44.460	-6.115	-1.843	.070	-170.727	6.806
Self-Concept*Stress	.039	.027	5.435	1.423	.159	-.016	.094
Gender*Self-Concept	1.526	.878	7.959	1.738	.087	-.227	3.278
Gender*Stress	1.508	.749	8.877	2.013	.048	.012	3.004
Gender*Self-Concept*Stress	-.028	.015	-10.315	-1.907	.061	-.058	.001

a. Dependent Variable: Achievement

Hypotheses 1

There is no significant contribution of teachers’ academic self-concept to the prediction of students’ achievement in Biology. The unstandardized coefficients for the moderator and predictor variables are displayed in Table 4.6 together with their corresponding t- and p-values. The table demonstrated that the independent variable significantly influenced the prediction of biology students' academic performance. Taking into account the degree of involvement, educators' perception of their own academic abilities, the unstandardized coefficient (B =.248) and the standardized coefficient or slope (β =.453) showed a significant difference from 0.000 ($t = 4.745$; $P < 0.05$). As a result, while controlling for gender, academic success rose by 25/100 points for every one point rise in instructors' academic self-concept. The null hypothesis was consequently rejected. The academic achievement of pupils in Biology was predicted by the teachers' academic self-concept, which had a statistically significant influence.

Hypotheses 2

There is no significant contribution of teachers’ academic stress to the prediction of students’ achievement in Biology. The unstandardized coefficients for model 1 are displayed in Table 4.6 together with the corresponding t- and p-values for the moderator and predictor variables. The independent variable significantly influenced the prediction of biology students' achievement, as the table demonstrated. The un-standardized coefficient (B = -.205) and standardized coefficient or slope (β = -.371) were substantially different from 0.000 ($t = -3.9056$; $P < 0.05$) when taking into account the degree of contribution and instructors' academic stress. This shows that while controlling for gender, pupils' academic achievement increased by 21/100 for every one point decrease in instructors' academic stress. Consequently, the null hypothesis was disproved. Teachers' academic stress was found to have a statistically significant impact on predicting students' academic progress in Biology.

Hypotheses 3

The joint contribution of teachers’ self-concept and academic stress are insignificant to the prediction students’ achievement in Biology. Model 2's unstandardized coefficients are included in Table 4.6 along with the moderator and predictor variables' corresponding t- and p-values. The table demonstrated that there was no statistically significant combined contribution from the independent variable to the prediction of Biology students' achievement. When taking into account the level of contribution, instructors' academic stress and self-concept, the standardized coefficient or slope (β = -1.672) and unstandardized coefficient (B = -.012) did not differ significantly from 0.000 (t = -.017; $P > 0.05$). This shows that, while controlling for gender, kids' academic achievement increased by 1.2/100 for every unit fall in instructors' academic self-concept and stress. As a result, the null hypothesis was accepted. Teachers' academic stress and self-concept did not significantly contribute to the prediction of students' academic progress in Biology.

Hypotheses 4

Gender has a negligible moderating effect on instructors' self-perception when it comes to forecasting biology students' academic success. Table 1 illustrates how gender modifies teachers' academic self-concept in model 2. Neither the standardized coefficient (β = -.689) nor the unstandardized coefficient (B = -.132) differed statistically significantly from 0.00 (t = -1.048; $P > 0.05$), indicating that the null hypothesis was not rejected. Consequently, there is no evidence that the moderating effect of gender on teachers' academic self-concept in predicting the academic achievement of secondary school Biology students.

Hypotheses 5

Gender has a negligible moderating effect on instructors' academic stress in terms of predicting biology students' progress. Table 1 illustrates how gender modifies the impact of academic stress on teachers in model 2. Neither the standardized coefficient (β =.608) nor the unstandardized coefficient (B =.103) differed statistically significantly from 0.00 (t =.737; $P > 0.05$), indicating that the null hypothesis was not rejected. Consequently, it is not noteworthy that gender has a moderating effect on teachers' academic stress in predicting secondary school Biology students' academic achievement.

Hypotheses 6:

When predicting students' achievement in Biology, the moderating effect of gender on the combined instructors' academic self-concept and academic stress is negligible. Table 4.6 illustrates how gender modifies the relationship between academic stress and teachers' self-concept. Neither the standardized coefficient (β = -10.315) nor the unstandardized coefficient (B = -.028) differed statistically significantly from 0.00 (t = -1.907; $P > 0.05$), indicating that the null hypothesis was not rejected. Thus, it seems unlikely that gender will have a moderating effect on teachers' academic stress and self-concept when it comes to predicting secondary school Biology students' academic achievement.

Discussion of the Findings

The study's findings demonstrated that secondary school biology pupils in the Enugu Education Zone are significantly predicted by the academic self-concept of their professors. The showed in an empirical terms that when there is 1% increase in teachers' self-concept by 1 standard deviation, the students' academic achievement increases by 24%. This shows that teachers' self-concept is a big factor in determination of students' outcome in school. The findings of the study in agreement with the findings of Onah (2023), and Ajmal and Rafique (2018), the academic self-concept was found to positively and significantly predict academic achievement by the researchers. The overall academic success of pupils in biology is positively impacted by teachers' perceptions of their own intellectual abilities.

The study also showed that students' academic success in biology is significantly impacted by teachers' academic stress. The findings presented in Table 3 provided empirical support for the degree of variation in students' academic performance that was linked to instructors' academic stress. The study found that for every standard deviation decrease in teachers' academic stress, students' academic achievement increases by 21%. The result is consistent with Cîrligeanu, (2017); Osagie, (2018), the researchers discovered negative variation of students' achievement as anchored to the teachers' academic stress. Again, the findings of Osagie (2018) disagreed with the present study as the researcher found positive prediction of academic stress with the achievement of the students.

The results further showed that there is no discernible relationship between academic stress and teachers' self-perceptions of their own academic performance and pupils' biological achievement. The result showed that teachers' self-concept cancelled the academic stress to a great extent; the figure displayed showed the empirical evidence. The finding is consistent with the study of Akomolafe and Ogunmakin (2013), who noted non-significant joint prediction of self-concept and locus of control on achievement of the students. The study's findings, which are shown in Table 6, showed that gender had no interaction effect on instructors' self-concept when it came to predicting students' achievement in biology. The results are in line with those of Ajmal and Rafique (2018), who also found no evidence of a substantial relationship between gender and self-concept and academic achievement. This shows that gender is not a factor in self-concept and as such is needed by all genders. Table 6 indicates that the study's findings did not show a significant interaction between gender and academic stress experienced by teachers and students' biology achievement. The finding is consistent with the findings of Cîrligeanu, (2017); Osagie, (2018); who observed non peculiarity of gender to academic stress. Stress is an element of distraction academic wise. On the other hand, the finding differs from that of Osagie (2018) and Jose, Caterina and Diego (2019) who observed that stress is more predominate on female counter part especially the married ones. The researcher attributed this high volume of stress on women to home chores and other required up bringing skills of the children. The study's findings, which are shown in Table 6, showed that gender had no interaction effect on instructors' perceptions of their own worth and academic stress when it came to predicting students' biology achievement. The results are in line with those of Akomolafe and Ogunmakin (2013), who observed that gender did not significantly influence students' achievement in conjunction with their self-concept and locus of control.

Conclusion and Recommendations

Based on the findings this study, the researcher concluded that teachers' academic self-concept and academic stress significantly predicted students' academic achievement in Biology in Enugu Education Zone. Also the combination of academic self-concept and academic stress has no significant impact on the students' achievement in Biology. Furthermore, Gender has no significant influence on teachers' self-concept and teachers' stress in predicting students' academic achievement in Biology. Finally, the researcher concluded that combination of teachers' academic self-concept and academic stress and gender has no significant impact on the secondary school Biology students'. Based on the findings, the researcher recommended that

1. State ministry of education in teamwork with post primary schools management board should organize seminars and workshop to help teachers to boost their self-concept will encourage them to develop positive self-concept that help them in teaching Biology.
2. Biology teachers should engage students with education activities, in such a way that it will help them develop positive self-concept.
3. State departments of health and education should plan school intervention programmes that will save teachers from the adverse effects of stress.
4. The findings if utilized by health educators, will enable them develop appropriate methods and approaches in teaching and handling of stress and stress problems of both teachers and students. This will enable teachers inculcate in themselves the desired knowledge, attitudes and skills necessary in dealing with stress.

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ENHANCING THE UNDERSTANDING OF BIOLOGY STUDENTS ON 'HOW' AND 'WHY' BIOLOGICAL PHENOMENA OCCUR THROUGH CAUSAL REASONING

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Abstract

Cause and effect of biological phenomena seem to remain ambiguous to most people, including biology students. Understanding the concept of biological phenomena requires proper articulation of biological concepts and scientific reasoning. This study on enhancing the understanding of biology students on how and why biological phenomena occur through causal reasoning was carried out in Enugu North local government area of Enugu State, Nigeria. The population of the study was 4,612 biology students in Enugu North local government area. The sample size was thirty (30) biology students. This was made up of one (1) male and one (1) female, biology student that were sampled through simple random sampling, by balloting, from each of the three senior secondary school classes of five public co-education schools in Enugu North local government areas. Pre-teaching and post-teaching of causal reasoning interviews were conducted on the students to determine the impact of teaching causal reasoning to the students. Data collected from their interview responses prior to the teaching and after the teaching of causal reasoning about biological phenomena were analyzed using Statistical Package for the Social Sciences (SPSS) and subjected to Chi-Square test at 0.05 level of significance, to determine the impact of the teaching on their understanding of how and why biological phenomena occur. The Chi-Square test result indicated that there was a significant association between causal reasoning with enhancement of the understanding of biology students on how and why biological phenomena occur. It was, therefore, recommended that teaching towards understanding how and why biological phenomena occurred, should be approached through scientific reasoning, by the teachers. Biology teachers should teach their students on how to think analytically and scientifically in order to understand and interpret biological phenomena.

Keywords: Causal reasoning, Biological phenomena and students.

Introduction

Considerable research exists on the development of causal reasoning in natural area including biology. Causal reasoning involves an interpretation of current events and explanation of past events. It involves identification of the cause-and-effect relationships that underpin biological phenomena. According to Legare (2008), a fundamental task for all humans is explaining 'how' and 'why' things happen. Causality according to

Goodman, Tomer and Joshua (2011) governs the relation between events. One particular skill that causal reasoning strengthens is critical thinking. As students develop the ability to identify causative factors in biology, they also learn to analyze and evaluate different biological phenomena. Animals and plants possess special features or structures that enable them adapt to their environments. There are basically three types of adaptations based on how the genetic changes are expressed. These are structural, physiological and behavioral adaptations. Structural adaptations are physical features of an organism's body that helps it to survive or reproduce within the environment. Unlike structural adaptation, physiological adaptation is internally based body chemistry and metabolism that enables the organism to survive in a changing environment. Behavioral adaptation on the other hand, is an organism's behavioral change in the face of a prey, predator, during mating/reproduction and changes weather condition. Structural, physiological and behavioral adaptations in plants and animals have shown some attendant causes and effects. Causes and effects of these biological phenomena seem to remain ambiguous to biology students (Mbajiorgu, Ezechi and Idoko, 2007). Understanding the concepts of biological phenomena requires proper articulation of biological concepts and scientific reasoning.

Malle, Moses and Baldioun, (2001), indicated that causal reasoning involves an interpretation of teleological or goal directed phenomena, the predication of future events and explanation of past events. According to Anidu, Eze and Mbajiorgu (2022), causal reasoning is the process of thinking about cause and effect from human minds tendency to provide causal explanations to the question of 'Why', 'How and 'What'. Gopnik (2001), has indicated that development of causal reasoning is particularly important in science learning as scientific invention such as hypothesis, theories and laws specifying causal relations among entities, events and processes. In Eze (2022), it was stated that causal reasoning is cause and effect related reasoning. Its purpose is basically to resolve the question of how and why phenomenon occurs. Proper knowledge structure and scientific conceptions are very necessary for biology student in resolving these questions on how and why a phenomenon occurred. Resolving these questions of how and why a phenomenon occurred involves mental process using causal reasoning. According to Mayr (2010), the idea of causal reasoning is to interpret what is seen as purposeful or goal seeking and predict how that behavior affects or effects what happens next.

To enhance the understanding of biology students on how and why biological phenomena occur through causal reasoning can be approached through any and or all of the following strategies:

Use of Real-Life Examples

This can be achieved by incorporating real-life examples and case studies to help students understand the cause-and-effect relationships in biological phenomena;

Encouraging Critical Thinking

This can be achieved by encouraging students to think critically about the biological process they are learning about. Charging them to analyze the factors that contribute to a particular outcome of different phenomena;

Interactive Activities

This can be achieved by engaging students in hand-on activities, experiments and simulations that will allow them to observe and understand the causal relationships in biological events;

Concept Mapping

This approach is by visually representing the causal relationships between different biological phenomena. It can help students see the interconnectedness of various processes and understand the underlying reasons for their occurrence.

Implementation of the above mentioned strategies can help biology students develop a deeper understanding of how and why biological phenomena occur, through causal reasoning.

Nevertheless, Bollocks, Gelman and Baillargon in Szymanowski (2008), identified three factors that could affect the interpretation, prediction and explanation of causal events in adults. These factors are;

1. the principles underlying definitions of cause and effects
2. the stimulus information utilized in making causal attributions and
3. The role of knowledge about objects in causal attribution and explanations.

The finding of the study would be anchored on theory of constructivism. Constructivism according to WNET (2004), is basically a theory – based on observation and scientific study about how people learned. It is a philosophical viewpoint about the nature of familiarity, awareness or understanding of someone or something, such as facts, information, descriptions or skill, which is acquired through experience or education by perceiving, discovering or learning. It is founded on the premise that, by reflecting on our experiences, we construct our own understanding of the world we live in.

Tamir and Zohar (1991) in Southerland and Hayne (2001) developed seven categories of reasoning that could enable biology students proffer answers to how and why biological phenomena occur.

These were:

Anthropomorphic: This attributes human as the causal agent for changes seen in non-human organisms. It also includes an explanation in which the organisms (human and non-human) is seen as been able to manipulated or effect the change willfully.

Teleology: This attributes the end as the agent of determining the nature of the phenomenon. It involves the identification of the inherent purpose, intent or end of a phenomenon.

Mechanistic Proximate: This attributes a specific physiological or biological agent to determining the nature of the phenomenon. Typically, such an explanation describes the actions of just the individual and does not consider the entire group or population of organisms.

Mechanistic Ultimate: This attributes a long term, generally, genetically based agent to determining the nature of the phenomenon.

Such explanation describes the entire characteristic of population of an organism and not just the actions of and individual.

Predetermined: This is where the agent is not clearly identified, thus the nature of the phenomenon is attributed to God or nature.

Blended: This reasoning combines the attributes of more than one of the category of reasoning to explain a phenomenon.

Don't know: This is a situation where the respondent does not know what to say or what to attribute the phenomenon to.

Statement of the Problem

Understanding and explanation of how and why biological phenomena occur have remained a big challenge to most biology students, including their teachers. The question, therefore is, can the understanding of biology students on how and why biological phenomena occur be enhanced through causal reasoning?

The purpose of the study was to determine if causal reasoning could enhance the understanding of biology students on how and why biological phenomenon occurs. Two research questions and two hypotheses were posed for the study.

Research Question 1

What is the association of causal reasoning with enhancement of the understanding of biology students on how biological phenomenon occurs?

Research Question 2

What is the association of causal reasoning with enhancement of the understanding of biology students on why biological phenomenon occurs?

Hypothesis 1

There is no significant association between causal reasoning with enhancement of the understanding of biology students on how biological phenomenon occurs.

Hypothesis 2

There is no significant association between causal reasoning with enhancement of the understanding of biology students on why biological phenomenon occurs.

Method

Survey research design was adopted for study. The population of study was 4,612 biology students from five (5) public co-education secondary schools in Enugu North local government area of Enugu state. Simple random sampling by balloting was used to sample one (1) male and one (1) female each of the three classes of senior secondary biology students giving a total of six (6) students from each school. Thus a total sample size of 30 students responded to interview. The instrument for data collection was an open-ended structured interview schedule (SIS) that was developed based on one animal specimen and one plant specimen that were used for the study. These were colored pictures of a chameleon (with changing color) and Nepenthes (with tongues). The interviews were designed for collection of data on the students' causal reasoning and their causal explanation on some identified biological phenomenon found in the animal and the plant. This was done to identify their choice of category of reasoning from the seven categories of reasoning as identified Tamir and Zohar in Southerland et al (2001). In order to identify their choices of categories of reasoning they were interviewed on how and why some identified biological phenomena occur in the chosen specimen (chameleon and Nepenthes). Pre-teaching of causal reasoning interview and post teaching of causal reasoning interview were conducted on the students.

The instrument was sent to three experts in the relate fields of the study for face validations. It was examined based on content area, appropriateness and clarity of the interview items to ascertain the extent to which the instrument could measure what it was meant to measure. The instrument was not subjected to reliability test as it was for soliciting open-ended responses.

1. Structured interviewed schedule (for chameleon)
    a. How did chameleon get behavioral coloration changes?
    b. Why did the chameleon have the behavioral coloration changes?

2 Structured interview schedule (for Nepenthes)
    a. How did the Nepenthes get its tongue?
    b. Why did the Nepenthes have tongues?

Data collected from pre-teaching interview and post-teaching interview was analyzed electronically using Statistical Package for the Social Sciences (SPSS) and tested with Chi-Square at 0.05 significant levels. The null hypothesis would be rejected if the Chi-Square test result was equal or greater than critical value at the appropriate degree of freedom, and would not be rejected if Chi-Square test was less than the critical value.

Results

Research Question 1

What is the association of causal reasoning with enhancement of the understanding of biology students on how biological phenomena occur?

Cross tabulation of pre-teaching and post-teaching of causal reasoning interview responses given by biology students with categories of reasoning, on how biological phenomena occur.

How Categories of Reasoning	Pre-teaching responses		Post-teaching responses		Total	
	Count	%	Count	%	Count	%
Anthropomorphic	0	0	0	0	0	0
Teleology	3	5	26	43.33	29	24.17
Mechanistic Proximate	8	13.33	6	10	14	11.67
Mechanistic Ultimate	18	30	20	33.33	38	31.67
Predetermined	25	41.67	4	6.67	29	24.16
Blended	6	10	4	6.67	10	8.33
Don't know	0	0		0	0	0
Total	60	100	60	100	120	100

The above table revealed that the students' choice of responses with scientific categories of reasoning were more after post-teaching of causal reasoning as against their pre-teaching of causal reasoning choice or responses. Their choice of mechanistic ultimate and teleology categories increased after teaching them causal reasoning, while their choice of non scientific categories of reasoning, like predetermined and blended, on how biological phenomena occur reduced.

Research Question 2

What is the association of causal reasoning with enhancement of the understanding of biology students on why biological phenomena occur?

Cross tabulation of pre-teaching and post-teaching of causal reasoning interview responses given by biology students with categories of reasoning, on why biological phenomena occur.

Why Categories of Reasoning	Pre-teaching responses		Post-teaching responses		Total	
	Count	%	Count	%	Count	%
Anthropomorphic	0	0	0	0	0	0
Teleology	4	6.67	28	46.67	32	26.67
Mechanistic Proximate	7	11.67	4	6.67	11	9.17
Mechanistic Ultimate	16	26.66	23	38.33	39	32.5
Predetermined	26	43.33	3	5	29	24.16
Blended	7	11.67	2	3.33	9	7.5
Don't know	0	0	0	0	0	0
Total	60	100	60	100	120	100

The above table revealed that the students' choice of responses with scientific categories of reasoning were more after post-teaching of causal reasoning as against their pre-teaching of causal reasoning choice or responses. Their choice of mechanistic ultimate and teleology categories increased after teaching them causal reasoning, while their choice of non scientific categories of reasoning, like predetermined and blended, on why biological phenomena occur reduced.

Hypothesis 1

There is no significant association between causal reasoning with enhancement of the understanding of biology students on how biological phenomena occur.

Chi-square test result for how biological phenomena occur

Description	Value	df	Sig(2sided)
Pearson Chi-Square	13.61	32 6	0.00
Number of Valid Cases	120		

Critical value $\chi^2_{0.05}=12.592$

Chi-square test result=13.6132

In line with the decision rule, the null hypothesis was rejected as the Chi-square test result was greater than the critical value at 6 degree of freedom. Hence, the alternative hypothesis which states that there is significant association between causal reasoning with enhancement of the understanding of biology students on how biological phenomena occur is accepted.

Hypothesis 2

There is no significant association between causal reasoning with enhancement of the understanding of biology students on why biological phenomena occur.

Chi-square test result for why biological phenomena occur

Description	Value	df	Sig(2sided)
Pearson Chi-Square	13.98	36 6	0.00
Number of Valid Cases	120		

Critical value $\chi^2_{0.05}=12.592$

Chi-square test result=13.9836

In line with the decision rule, the null hypothesis was rejected as the Chi-square test result was greater than the critical value at 6 degree of freedom. Hence, the alternative hypothesis which states that there is significant association between causal reasoning with enhancement of the understanding of biology students on why biological phenomena occur is accepted.

Findings

Prior to teaching of causal reasoning the biological students were using non scientific reasoning in explaining how and why biological phenomena occur. Their choices of categories of reasoning inclined more to the use of predetermined category of reasoning, which was a non scientific way of reasoning. On the contrary, after the teaching of causal reasoning the biology student choice of reasoning changed to scientific ways of reasoning by inclining more the use of mechanistic ultimate and teleology reasoning categories as their choice of reasoning to understand how and why biological phenomena occur. Mechanistic ultimate and teleology categories of reasoning implore systematic observations, recording of occurrences and interpretation of occurrences before making conclusive statements.

Discussions of the Findings

The chi-square test result indicated that the association of causal reasoning with enhancement of understanding of biology students on how and why biological phenomena occur was significant. The choice of use of mechanistic ultimate and teleology categories of reasoning increased after teaching the students, causal reasoning. This implies that many of the biology students relinquished their presuppositions on biological phenomena and became more analytical of the causal agency through constructive reasoning. Progressive psychologists explore the growth and expansion of reasoning from birth to maturity. According to Demetrions, Monyi & Spanoudis (2010) changes in reasoning with development come from increasing work, education, and memory capacity, increase speed of processing, enhanced executive functions and control, including self awareness. It would be appropriate to expect difference in students' causal reasoning as they receive and acquire more scientific education. This might be the reason why the chi-square test result indicated that there was significant association between causal reasoning with the enhancement of these biology students' understanding of how and why biological phenomena occur.

Conclusion

Enhancing the understanding of biology students on how and why biological phenomena occur through causal reasoning, has been identified as a veritable tool for biology students' understanding and explaining cause-and-effect of biological phenomena. Understanding and explanation of cause-and-effect of biological phenomena have remained big challenge to secondary school biology students and in most cases impact negatively on their academic performances. The major reason for the poor performance of biology students in explanation of biological phenomena is their lack of ability to reason in scientific ways. Causal reasoning is a scientific approach to teaching and understanding how and why biological phenomena occur. It implores some strategies to instill knowledge and understanding of biological phenomena on biology students. The seven categories of reasoning by Tamir and Zohar (1991), is one of the strategies in use.

This particular strategy presents seven different ways of viewing any biological phenomena as to understand how and why it occurred. The results of both hypotheses posed in this work have shown that the biology students that passed through causal reasoning tutelage performed better in understanding how and why biological phenomena occurred. Teaching and learning of biology that is based on causal reasoning most often, enhance biology students' understanding of biology and biological phenomena.

Recommendations

Based on the finding of the study, it was recommended that teaching towards understanding how and why biological phenomena occur should be approach through scientific reasoning. Students should be taught on how to think analytically and scientifically using different causal reasoning strategies, in order to understand the phenomena. In most case, cause-and-effect of any phenomenon transcend what the normal eye could see, how and why it happen, the nature and intent of the phenomenon need to be understood. This can only be achieved through causal reasoning, which has to do with analyzing current event and predicting the future effect of such event.

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EFFECTS OF IMMEDIATE AND DELAYED FEEDBACK MODES OF ASSESSMENT ON STUDENTS' ACHIEVEMENT AND RETENTION IN CHEMISTRY

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Abstract

The purpose of the study was to ascertain the effect of immediate and delayed feedback modes of assessments on students' Achievement in Chemistry. Four research questions and four null hypotheses guided the study. Pretest-posttest non-equivalent control group quasi-experimental research design was adopted for the study. The population for the study comprised of 2,296 senior secondary class two (SS II) students offering chemistry in 21 co- educational secondary schools of Enugu Education Zone in Enugu State. A sample of 144 SSII students drawn from 3 public secondary schools in the zone was used for the study. A purposive sampling method and simple random sampling techniques were employed in the study. The instrument for data collection was chemistry achievement test (CAT) which consisted 40 test items. The instrument was validated by three experts; one expert in Measurement and Evaluation and the other two in Science Education. The reliability of was determined using Kuder-Richardson's formula-20 (K-R20) and the reliability coefficient obtain was 0.82. The instrument was administered as pretest and posttest. Mean and standard deviation were used to answer the research questions while the Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The Statistical Package for Social Science (SPSS) was used for all the analyses. The result of the analysis revealed that students who received immediate and delayed feedback modes of assessments achieved better than students who did not receive feedback. It was also revealed that students who received delayed feedback had higher achievement scores than students who received immediate feedback. Moreover the result showed that gender had no significant effect on students who received immediate feedback. The study recommended that chemistry teachers should ensure that students are given delayed feedback to enhance their achievement in chemistry.

Keywords: *Chemistry, Achievement, Immediate, Delayed and Feedback*

Introduction

Chemistry is one of the basic sciences needed for a nation's technological breakthrough. Chemistry is a branch of science which deals with the study of the structure, composition, properties and reactions of matter in different forms (Omeke, 2012). Ameh (2014), noted that chemistry is pre-occupied with the molecular transformation and manifestation of matter, implying that Chemistry is involved in industrial production of fertilizer, soap, petroleum, drugs, beverages, recycling of waste materials, and the improvement of the quality of life of the citizenry. It therefore follows that a sound theoretical and practical knowledge of Chemistry is a pre-requisite for technological advancements in Nigeria. Despite the importance of Chemistry, it has not succeeded in producing the objective of Chemistry teaching in Senior Secondary School as stipulated in Senior Secondary School Chemistry Curriculum. The objective of senior secondary school Chemistry Curriculum is to enable students to; develop interest in the subject of chemistry, acquire basic theoretical and practical knowledge and skills, provide students with basic knowledge in chemical concepts and principles through efficient selection of contents and sequencing. acquire basic STM knowledge and skills, apply skill to meet societal needs of creating employment and wealth, show chemistry and its inter-relationship with other subjects, show chemistry and its links with industry, everyday life activities and hazards (FME, Senior Secondary Education Chemistry Curriculum, 2013)

None achievement of the objectives of chemistry teaching in senior secondary school, is evident in the form of poor students' achievement in Senior Secondary School Chemistry examination. For instance, research reports by Udoka (2020), and Agbo (2021), indicated students' low performance in Chemistry. Also, in the Chief Examiners report of 2017, 2018, 2019, 2020 and 2021 respectively attest to the evidence of poor achievement in school Chemistry. According to these researchers, in 2017 for the WAEC Examination, the percentage of Secondary School Chemistry students who had between A_1-C_6 was 36.55% while 63.45% had between D_7-F_9. In 2018, 34.50% had between A_1-C_6 while 65.50% had between D_7-F_9. In 2019 36.91% had between A_1-C_6 while 64.09% had between D_7-F_9. In 2020, 34.52% had between A_1-C_6 while 65.48% had between D_7-F_9. In 2021, 33.55% has between A1 – C6 while 66.45% had between D7 – F9.

In 2014, NECO Examination results, the percentage of secondary school Chemistry students who had between A_1-C_6 was 39.92% while 60.08% of students had between D_7-F_9. In 2015, 15.56% had between A_1-C_6 while 84.44% between had D_7-F_9. In 2016, 23.00% had between A_1-C_6 while 77% had between D_7-F_9. In 2017, 31.00% had between A_1-C_6 while 69.00% had between D7-F9. In 2018, 25.09% had between A_1-C_6 while 74.01% had between D_7-F_9 (NECO Chief Examiners Report, 2014, 2015, 2016, 2017, 2018). These statistics is alarming as students' performance continue to decline year after year. The poor performance tends to suggest that chemistry education in Nigeria is largely unsatisfactory.

Educators and parents have expressed their great concern over the poor performance of students in Chemistry. There have also been discussions and researches on who takes responsibility for the poor performance in Chemistry. Some parents tend to accuse the teacher and indeed the school for the poor performance of the students in Chemistry. Some teachers on the other hand tend to return the blame to the parents arguing that children stay more with their parents than with the teachers. However, the fact still remains that the problem associated with Chemistry teaching and learning is an indication that some factors in the learning situation tends to inhibit students from performing as expected in the subject. Considerable research studies are being expended on how to improve students' achievement in Chemistry. A report by Ezeudu (2012), suggested that a re-orientation in the teaching, learning and evaluation procedure for better result is appropriate. Ezeudu emphasized the need to seek out innovative method of teaching and evaluation of the subject. Similarly, Agbo (2018), observed that there is a need for a change from the current method of evaluation, if students' achievement in Chemistry must improve.

Feedback is defined as the response which completes the cycle of communication from the source to the receiver and back to the source (Sinha, 2012). Feedback, once it is provided, makes the students concerned to begin to have better understanding of his/her capabilities and develop capacity to monitor, evaluate and regulate their own learning (Lemley, 2017). Stephene (2019), opined that feedback can motivate students and provide information they can use to improve or correct their learning. It also provides the teacher the opportunity to improve on the quality of imparted knowledge. The interaction students have through feedback influence them to understand how to develop their own learning. The essence of using feedback during the instructional process is to guide, direct and monitor students learning and progress towards achievement of course objective (Ajogbeje, 2012, & Afemikhe, 2015). In order words, the main objective of feedback according to Nizol (2010), are to; (i) justify to students how their marks or grade were desired (ii) identify and reward specific qualities in students work (iii) guide students on what steps to take to improve and (iv)motivate them to act on their assessment.

The use of feedback, in a classroom can be as simple as writing a few notes on students' essay, Chemistry homework, quiz, correcting a paper among others. Classroom activities such as writing or telling students how to find the right answer to a question allows them to understand the concept better, and know why they got it wrong and how they can correct it (Norlin, 2014). Quinn, (2014), is of the view that feedback provided as soon as the learner replies to a question or completes an assignment promotes retention of learned information. Feedback is most productive to a students' learning when they are provided with an explanation and examples as to what is accurate and inaccurate about their work. Studies have shown that when feedback is predominately negative, it can discourage students' effort and leads to lower achievement (Reyes, 2013). In order words, a teacher has a distinct responsibility to provide feedback in such a manner that the student does not leave the classroom feeling defeated. In addition, Ezekwesili and Ngonebu, (2015), posited that immediate and delayed feedback imparts students' progress or lack of progress in school subject more easily than other forms of feedback.

Immediate feedback is defined as scores for homework, quizzes and tests which are given to students and which serves as the guidelines they need to adjust their own learning and provides information to the correctness or incorrectness of their response immediately after a formative test (Sinha, 2012). Gaknep (2011) noted that immediate feedback aids learning as behaviour is observable and still fresh in memory and thus promotes retention of learned information. When feedback is given immediately, after showing proof of learning, the student responds positively and remembers the experience about what is being learnt in a confident manner (Sinha, 2012). In order words, if the time taken is too long to give feedback, the memory might be lost and the student might not connect the feedback with action. Immediate feedback is therefore assumed an imperative assessment procedure in teaching and learning, however, its effect on students' achievement and retention in chemistry is not yet known. This created the gap for the study.

Delayed feedback on the other hand refers to the provision of information feedback four or five days after a test has been taken. It is a corrective measure that is provided not as soon as the learning experience is initiated (Lemley, 2017). Opitz (2011) asserted that delayed feedback occurs when there is a period of time between skill execution and feedback. Delayed feedback contrast with immediate feedback in that immediate feedback occurs immediately on the spot. Tori (2015) suggested that delayed feedback encourages learners to anticipate the answer, which may increase their level of attention to it when they receive it. The decision whether to correct immediately or later depends on various factors which include aims, class dynamics, learners attitude and expectation, motivation level or whether a mistake or an error has been made. One major advantage of delayed feedback as stipulated by Reyes (2013) is that students' response lack perspective. For instance, students might not understand the basis of some subject matter choices made by the teacher until much later or after the next assignment. Delayed feedback is assumed to arouse students' curiosity to learning and assessment. However, its effects on students' achievement and retention in chemistry is a gap yearning for urgent attention and this formed the concern of this study.

Achievement refers to the degree of success attained in some general or specified area (Chianson, 2011). Academic achievement in the context of this study can be defined as the quality of result produced by students as reflected in the quality of students' examination scores (Musa, 2015). It is a yard stick for measuring learning. It therefore follows that poor academic achievement indicates no, little or insufficient learning (Ameh, 2014). In order words, it is only what is learnt that is expressed as academic achievement.

Despite the general agreement among education stakeholders (Odoh, 2012, & Muhammad, 2019),that feedback plays important roles on students' achievement and retention, many studies are being conducted to address the impact of immediate versus delayed feedback on achievement and retention in other subjects and discipline. For instance the result of the study conducted by Yekta and Dafeian (2016), on effect of immediate or delayed feedback on vocabulary knowledge in English indicated that teachers' delayed feedback was significantly more successful than immediate feedback. This is in consonance with the study of Metcalfe, Kornell, and Finn, (2013), which indicated that delayed feedback was significantly more successful than immediate feedback after investigating students' memory performance in English. The above findings were contradicted by the result of Kheradmand and Sayadiyan (2016), which indicated that students achieved more with immediate feedback than delayed feedback in writing accuracy in English. This corresponds with the findings of Aglah, Zotorvie, Tsrah and Akpastu (2014), who revealed that students perform better with immediate feedback than with delayed feedback in mathematics. Findings from Ezekwesili and Ngonebu (2015), revealed that students who receive delayed feedback performed better than those who receive immediate feedback in English Language. These findings disagreed with the findings of Ajogbeje (2012), which discovered that students who received immediate feedback performed better than those with delayed feedback in Mathematics. Being that the secondary school students are the targeted population for this study, it is worthy to note that the secondary school students under study are made of both male and female, thus, the use of delayed and immediate feedbacks and its effect on students' achievement and retention is dependent on some variables such as gender of secondary school students.

Gender is described as the biological sex of an individual in terms of being male or female. It has to do with socially expected behaviours of male and females. In Nigerian society, there are differences and inequalities in the assignment of responsibilities between women and men, activities taken, access to and control over resources as well as possession of some qualities (Adigwe, 2014). The influence of gender on students' achievement and retention have for a long time been of serious concern of many researchers and scholars. This is because no consistent result has been established on the effect of gender on the students' achievement and retention in chemistry. Ameh (2014), found that students' gender influenced their academic achievement and retention in chemistry. The above study differed from the study of Omeke (2012), who posited that there was no significant difference in academic achievement of male and female students in chemistry. This was contradicted by Apper (2016), who asserted that female students achieved and retained more in chemistry than their male counterparts. In the opinion of Ogbonna (2010), gender has no effect on student's achievement in chemistry. These contradictory findings are what necessitated the present study to find out the influence of gender on students' achievement in chemistry when they received immediate and delayed feedback.

The above background indicated that there is no consensus on the type of feedback that increases the achievement of students in subjects despite the benefits of immediate and delayed feedback. The researcher is not aware of any study that has explored the effect of immediate versus delayed feedback on students' achievement in chemistry in Enugu Education Zone of Enugu State. Therefore, there is need to find out which of the two types of feedback that increases students' achievement in chemistry. It is against this backdrop that the present study is aimed at determining the effect of immediate and delayed feedback on students' achievement in Chemistry in secondary schools in Enugu Education Zone of Enugu State.

Statement of the Problem

Despite the relative importance of Chemistry in improving the quality of life of the citizenry, students' performances in the subject in both internal and external examination have remained consistently poor. Chemistry educators are trying to identify the major problems associated with the teaching and learning of Chemistry in the secondary schools in Nigeria. Research findings has shown that poor students' achievement and retention in Chemistry can be traced to ineffective mode of assessment which can cause poor achievement and retention. An effective evaluation should result in improving students' learning through constant feedback. It is also known that one of the behaviours exhibited by students is the eagerness to get information regarding their performance in tests and assessment. However, results of number of studies revealed that teacher's feedback was related to students' greater achievement, but very little is known as to the effect of immediate and delayed feedback in evaluating students' achievement in chemistry. Being that no researcher ever investigated the effect of immediate and delayed feedback on students' achievement in chemistry in Enugu Education Zone, to the best knowledge of the researcher. Thus, the researcher is motivated to investigate the effect of immediate and delayed feedback on students' achievement in chemistry in Enugu Education Zone of Enugu State.

Purpose of the Study

The purpose of this study is to determine the effect of immediate and delayed feedback on students' achievement in Chemistry in Secondary Schools in Enugu Education Zone. Specifically, the study sought to;

1. determine the mean achievement scores of students who received immediate feedback and those who did not receive feedback in chemistry.
2. ascertain the mean achievement scores of students who received delayed feedback and those who did not receive feedback in chemistry.
3. compare the mean achievement scores of students who received immediate feedback and those who received delayed feedback in chemistry.
4. examine the mean achievement scores of male and female students who received immediate feedback and those who received delayed feedback in chemistry.

Research Questions

The following research questions will guide the study.

1. What is the mean achievement score of students who received immediate feedback and those who did not receive feedback in chemistry?
2. What is the mean achievement score of students who received delayed feedback and those who did not receive feedback in chemistry?
3. What is the mean achievement score of students who received immediate feedback and those who received delayed feedback in chemistry?

4. What is the mean achievement score of male and female students who received immediate feedback and those who received delayed feedback in chemistry?

Hypotheses

The following null hypotheses were raised and tested at .05 level of significance.

1. There is no significant difference in the mean achievement scores of students who received immediate feedback and those who did not receive feedback in chemistry.
2. There is no significant difference in the mean achievement scores of students who received delayed feedback and those who did not receive feedback in chemistry.
3. There is no significant difference in the mean achievement scores of students who received immediate feedback and those who received delayed feedback in chemistry.
4. There is no significant difference in the mean achievement scores of male and female students who received immediate feedback and those who received delayed feedback in chemistry.

Method

The research design adopted for the study is quasi-experimental design. Specifically, the design employed is a pre-test, post-test, non-equivalent, control group design. The design was chosen because the subjects for the study were not manipulated or randomized. Intact classes were used and the classes were randomly assigned to experimental and control groups. Ameh (2014), noted that, quasi-experimental design is a school friendly type of design in that it can be used in schools without any major disruption in school structure or timetable of academic events. The choice for quasi-experimental design was dictated by the fact that it is useful to identification of case-and-effect in any given study. Thus the researcher employed quasi-experimental design to identify the effect of immediate and delayed feedback on students' achievements in chemistry. The population for the study was made up of Two thousand, two hundred and ninety six (2296) senior secondary class two (SS II) students who were offering chemistry in the 21 co-educational public secondary schools in Enugu Education Zone (PPSMB, 2022).The 21 co-educational public secondary schools in Enugu Education Zone comprised; 4 secondary schools in Enugu East L.G.A, 5 secondary schools in Enugu North Local Government Area. and 12 secondary schools in Isi-Uzo. The choice of SS II students was based on the fact that the topic "chemical equilibrium" is in the chemistry syllabus for SSII students and also they are not in examination class to avoid distracting them from preparing for the external examination. The sample for the study is one hundred and forty four (144) senior secondary class two chemistry students' (81 males and 63 females). Purposive sampling technique was adopted to draw three co-Educational schools from the 21 secondary schools identified to have large students' enrolment. One school each was sampled from each of the three LGAs (Enugu North, Enugu East and Isi-Uzo) in the zone. A further simple random sampling technique was employed to select one (1) intact class from each of the three sampled schools. Simple random technique was employed because it gave all the intact classes in each of the sample schools equal chance of being selected. The three intact classes selected were assigned to the three groups (two treatment groups and one control group) using the same simple random techniques. The treatment groups received immediate feedback (50 students) and delayed feedback (48 students) while the control group did not receive any feedback (46 students). The instrument for data collection is Chemistry Achievement Test (CAT) on Chemical Equilibrium. The CAT is a 40-item test package, developed by the researcher from the content area of the study. The CAT contained two sections: Section A, covered the students' personal data while section B comprised of 40 multiple choice questions, with four (4) options lettered (A-D) for each question. Questions were used from the contents of the lesson on chemical equilibrium.

The instrument was validated by three experts, two in Science Education Department and one in Mathematics and Computer Education Department, all from the Faculty of Education, Enugu State University of Science and Technology (ESUT), Enugu. The instrument was validated in terms of clarity of instructions, proper wording of items, appropriateness and adequacy of the items in addressing the purpose and problem of the study. The critical appraisals and comments of those experts were used for modifying the items to ensure that it measured what it was designed to measure. The reliability of CAT was established through trial testing by using fifty (50) SS II chemistry students from Model Secondary Co-Educational School in Nsukka Education Zone of Enugu State. Those students were similar to the students that were used for the study in terms of Age, Sex, among others. The reliability of CAT was determined by using Kudder-Richardson's formula 20 (K-R-$_{20}$). The choice of K-R-$_{20}$ was because the instrument used was a multiple choice test items with right and wrong option. Moreover, it is an appropriate method used in determining the internal consistency of items that are scored dichotomously. The internal consistency index obtained for CAT using K-R-$_{20}$ was 0.82. Three (3) regular chemistry teachers in the three sample schools who served as research assistants in the study were exposed to pre-experimental training programme by the researcher for three days. The training session was conducted in Government Technical College (GTC) class room. It was easy by the researcher to bring all the three research assistants together for the training programme since all of them are residing in Enugu Metropolis. It was equally their decision to carry the training together. Two sets of instructional packages (lesson plan) for teaching the unit of chemical equilibrium were prepared by the researcher. The instructional packages were used for both the treatment and control groups. The programme helped in establishing a common instructional standard among the chemistry research assistants. The pre-CAT was administered to the students before the commencement of teaching as well as treatment by the research assistants in the sample schools.

The pre-CAT was used to determine the students' knowledge of the topic and also to determine the comparability of the three groups (experimental and control groups) with respect to their achievement in pre-test scores. The teaching of the topics for the study lasted for two (2) weeks for each school involving three periods of forty (40) minutes per week. The teaching method which was lecture method was the same for both treatment (immediate and delayed feedback) and control group (No feedback) in the three (3) intact classes from the sampled schools used for the study. The treatment and control groups were taught using the same teaching method because the study centered on giving immediate or delayed feedback on the result of chemistry test (pre-test) which was administered to the students. The main treatment for the study was the feedback which the student received on correctness or incorrectness of their responses in the pre-test scores using two treatment procedures (immediate and delayed feedback). The immediate feedback group were exposed or shown the correctness and incorrectness of their responses as reflected in their scores immediately after the pre-test. This was done by first of all, collecting the students' scripts immediately after completion of the test administered, marking and scoring the scripts by the teacher using the marking scheme. The marked scripts (question papers students supplied their answers in) were then returned to the students immediately to look at where they got it right or wrong. The teacher at the same time provided an explanation or feedback as to what was accurate and inaccurate about the answers supplied by students in the pre-test so that students would understand why and how they got it right or wrong. After the explanation by the teacher, the pre-CAT student's question papers with the supplied answers were taken away from the students for recording. The delayed feedback group were exposed to or shown the correctness or incorrectness of their responses as reflected in their scores two (2) weeks after the pre-test (After two (2) weeks of teaching). This was carried out by collecting the students' supplied answered scripts immediately after the completion of the test administered to them for marking and scoring by the teacher using marking scheme. The marked scripts was then returned to the students after completion of two (2) weeks teaching of the students to look at where they got it right or wrong. The teacher at the same time provided an explanation or feedback as to what was correct or incorrect about the answers to students' pre-test so that students would understand why and how they got it right or wrong. After the explanation by the teacher, the pre-CAT question papers containing the supplied answers by the students were taken away by the teacher.

The control group were not exposed to or provided with information about the correctness or incorrectness of their responses or answers as reflected in their pre-test scores. The teacher administered the pre-test to the students and collected the answered scripts at the end of the time allocated for the test for marking and scoring. The marked scripts were not returned to the students and the students were not given any feedback as to the correctness or incorrectness of their answers to the pre-test. After treatment for both treatment groups, the post-test were then administered to the students (the treatment and control groups) after two (2) weeks. The answer scripts were collected from students after the post-test for marking and proper recording of scores in line with the marking scheme. The pre-CAT and post-CAT were the same set of questions but the questions were reshuffled (i.e. re-numbered) in the post-CAT. The researcher did not teach the students. This was done by their regular classroom teachers of the participating classes but under the supervision of the researcher. The materials for teaching the students were prepared by the researcher. The researcher organized a pre-experimental training program for the chemistry teachers of the intact classes used for the study to ensure common instructional standard among chemistry teachers and to adhere strictly to procedure to ensure uniformity. At the end of the training, the teachers practiced the procedure and applied them as they relate to giving feedback to the students. To solve the problem of inter-class discussion among students, one intact class only was used in each school in each local government. Due to the nature of the administrative set up in the school, there was non-randomization of research subjects since the students had already been organized in classes. Effect of pre-test on post-test: The post-test was conducted three weeks after pre-test and it is expected that this period is long enough not to permit the pre-test to affect the post-test scores. Moreover, the researcher reshuffled/renumbered the items of the post-test before administering the post-test to the students. After administration of the Chemistry Achievement on the students by the Chemistry teacher, the CAT were collected, marked and the scores for both the experimental and control groups were recorded accordingly. The test items in both the pre-test, and post-test were scored one (1) mark each. The maximum mark was forty (40) while the lowest mark was zero (0) Mean and Standard deviation were used to analyze data and provide answers to research questions. Analysis of covariance (ANCOVA) was used to test hypotheses at .05 level of significance. ANCOVA was used to correct the error of initial differences in ability levels among the research subjects. They were calculated using statistical package for social science (SPSS) software. The following decision rule guided the study. Reject the null hypotheses if the *p*-value of the test statistics is less than or equal to 0.05 level of significance set for the study, otherwise fail to reject.

Results

Research Question 1

What are the mean achievement scores of students who received immediate feedback and those that did not receive feedback when taught chemistry.

Table 1: Mean Achievement and Standard Deviation Scores of Students who Received Immediate Feedback and those that did not Receive Feedback when Taught Chemistry

Group	N	Pretest mean ($\bar{x}$)	Pretest SD(σ)	Posttest mean ($\bar{x}$)	Posttest SD(σ)	Mean Score Difference
Control(No Feedback)	46	19.01	22.02	52.76	10.66	33.75
Experimental(Immediate feedback)	50	26.62	9.04	74.68	8.02	48.06
Mean Difference	**96**	**7.61**		**21.92**		**14.31**

Table 1 shows the mean achievement scores and standard deviation of students who received immediate feedback and those that did not receive feedback (control) when taught chemistry. The result of the analysis showed that students who did not receive any feedback (control) obtained mean scores of 19.01 and 52.76 respectively in their pretest and posttest with corresponding standard deviations of 22.02 and 10.66. On the other hand, students who received immediate feedback had mean scores of 26.62 and 74.68 respectively in their pretest and posttest with corresponding standard deviations of 9.04 and 8.02. From the result, it showed that learning took place. This is because the two groups achieved higher posttest mean scores than their pretest mean scores. However, the posttest mean achievement scores of the experimental group (immediate feedback) was higher than the posttest mean achievement scores of the control group. Moreover, the standard deviation scores of posttest for students who received immediate feedback was 8.02 while control group is 10.66 indicating that the students individual scores were clustered around the mean with the experimental group(immediate feedback) than control group(No feedback). Hence, it was deduced that students who received immediate feedback achieved higher than those with no feedback.

Research Question 2

What are the mean achievement scores of students who received delayed feedback and those that did not receive feedback when taught chemistry

Table 2: Mean achievement and standard deviation scores of students who received delayed feedback and those that did not receive feedback when taught chemistry

Gender	N	Pretest mean ($\bar{x}$)	Pretest SD(σ)	Posttest mean ($\bar{x}$)	Posttest SD(σ)	Mean Score Difference
Control(No Feedback)	46	39.52	9.29	46.60	8.80	7.08
Experimental(Delayed feedback)	48	46.74	11.27	60.21	7.96	13.47
Mean Difference	**94**	**7.22**		**13.61**		**6.39**

Table 2 shows the mean achievement scores and standard deviation of students who received delayed feedback and those that did not receive feedback (control) when taught chemistry. The result of the analysis showed that students who did not receive any feedback (control) obtained mean scores of 39.52 and 46.60 respectively in their pretest and posttest with corresponding standard deviations of 9.29 and 8.80. On the other hand, students who received delayed feedback had mean scores of 46.74 and 60.21 respectively in their pretest and posttest with corresponding standard deviations of 11.27 and 7.96. From the result, it showed that learning took place. This is because the two groups achieved higher posttest mean scores than their pretest mean scores. However, the posttest mean achievement scores of the experimental group (delayed feedback) was higher than the posttest mean achievement scores of the control group. In addition, the standard deviation scores of posttest for students who received delayed feedback was 7.96 while control group is 8.80 indicating that the students individual scores were clustered around the mean with the experimental group(delayed feedback) than control group(No feedback). Hence, it was deduced that students who received delayed feedback achieved higher than those with no feedback.

Research Question 3

What are the mean achievement scores of students who received immediate feedback and those that received delayed feedback when taught chemistry

Table 3: Mean achievement and standard deviation scores of students who received immediate feedback and those that received delayed feedback when taught chemistry

Group	**N**	**Pretest**		**Posttest**		**Mean Score Difference**
		mean ($\overline{x}$)	**SD(σ)**	**mean SD(σ)**	**($\overline{x}$)**	
Experimental (Delayed Feedback)	50	45.16	12.80	73.63	9.85	28.47
Experimental(Immediate feedback)	48	41.95	9.58	52.61	11.01	10.66
Mean Difference	**98**	**3.21**		**21.02**		**17.81**

Table 3.shows the mean achievement scores and standard deviation of students who received immediate feedback and those who received delayed feedback when taught chemistry. The result of the analysis showed that students who received immediate feedback obtained mean scores of 41.95 and 52.61 respectively in their pretest and posttest with corresponding standard deviations of 11.01 and 9.85. On the other hand, students who received delayed feedback had mean scores of 45.16 and 73.63 respectively in their pretest and posttest with corresponding standard deviations of 12.80 and 9.58. From the result, it showed that learning took place. This is because the two groups

achieve higher posttest mean scores than their pretest mean scores. However, the posttest mean achievement scores of the experimental group (delayed feedback) was higher than the posttest mean achievement scores of experimental group (immediate feedback). In addition, the standard deviation scores of posttest for students who received delayed feedback was 9.58 while those who received immediate feedback was 9.85 indicating that the student's individual scores were clustered around the mean with the experimental group (delayed feedback) than immediate feedback. This is an indication that students who received delayed feedback achieved more than those who received immediate feedback.

Research Question 4

What are the mean achievement scores of male and female students who received immediate feedback and delayed feedback when taught chemical equilibrium?

Table 4: Mean achievement and standard deviation scores of male and female students who received immediate feedback and delayed feedback when taught chemistry

Gender	**N**	**Pretest**		**Posttest**		**Mean Score Difference**
		mean ($\bar{x}$)	**SD(σ)**	**mean ($\bar{x}$)**	**SD(σ)**	
Male (immediate feedback)	28	39.52	9.29	60.60	9.96	21.08
(delayed feedback)	20	42.56	10.11	71.23	7.55	28.67
Female (immediate feedback)	26	46.74	11.27	59.60	10.28	12.86
(delayed feedback)	24	36.74	11.34	47.30	7.86	10.67
Total	**98**					

Table 4.shows the mean achievement scores of male and female students who received immediate feedback and delayed feedback when taught chemistry. The result of the analysis, showed that the posttest mean achievement scores and standard deviation of male students in the immediate feedback were 60.60 and 9.96 respectively, while that of female students were 59.60 and 10.28 respectively. In the delayed feedback,, the mean achievement scores and standard deviation of male students were 71.23 and 7.55 while that of female students were and 47.30 and 7.86 respectively. The analysis showed that male students had higher mean achievement score and smaller standard deviation than their female counterpart. This implies that the mean achievement scores of the male students was homogenous than that of female, and the male students achieved more in the immediate feedback than the female counterpart. While in the delayed feedback going by the mean, also indicates that male achieved more than their female counterpart when taught chemistry.

Hypotheses

Hypothesis 1: There is no significant difference between the mean achievement scores of students who received immediate feedback and those that did not receive feedback when taught chemistry.

Table 5: Summary of One-way ANCOVA on the mean rating achievement scores of students who received immediate feedback and those that did not receive feedback when taught chemistry.

Source	Type III Sum of Squares	df	Mean Square	f	Sig.
Corrected Model	.046[a]	1	.046	.036	.850
Intercept(immediate and no feedback)	2015.462	1	2015.462	1557.788	.000
Immediate feedback	.046	1	.046	.036	.000
Error	395.902	94	1.294		
Total	2412.000	96			
Corrected Total	395.948	95			

a. R Squared = .000 (Adjusted R Squared = -.003)

Table 5 shows that F (1, 94) = 0.036 and sig = 0.000. Since the significant value for treatment *p* = 0.000 < 0.05, the test statistic is considered significant. The null hypothesis of significant difference between the mean achievement scores of students who received immediate feedback and those that did not receive feedback when taught chemistry was rejected. This means that the difference in mean achievement scores of students who received immediate feedback and those that did not receive feedback when taught chemistry was statistically significant.

Hypothesis 2: There is no significant difference between the mean achievement scores of students who received delayed feedback and those that did not receive feedback when taught chemistry.

Table 6: Summary of One-way ANCOVA on the mean achievement scores of students who received delayed feedback and those that did not receive feedback when taught chemistry.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.374[a]	1	.374	.289	.591
Intercept(delayed and no feedback)	1859.283	1	1859.283	1438.264	.000
Delayed Feedback	.374	1	.374	.289	.026
Error	395.574	94	1.341		
Total	2412.000	96			
Corrected Total	395.948	95			

a. R Squared = .001 (Adjusted R Squared = -.002)

Table 6shows that F (1, 94) = 0.289 and p = 0.026. Since the significant value for method *p* = 0.026 < 0.05, the test statistic is considered to be significant. There was a significant difference between the mean achievement scores of students who received delayed feedback and those that did not receive feedback when taught chemistry was rejected. Thus, treatment was a significant factor as regards students' achievement in teaching chemistry.

Hypothesis 3: There is no significant difference between the mean achievement scores of students who received immediate feedback and those that received delayed feedback when taught chemistry.

Table 7: Summary of One-way ANCOVA on the mean achievement scores of students who received immediate feedback and those that received delayed feedback when taught chemistry.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7042.721[a]	1	7042.721	71.995	.000
Immediate feedback	7142.821[a]	1	7142.821	72.913	.000
Intercept	968444.000	1	968444.000	9900.060	.000
Delayed feedback	7042.727	1	7042.727	71.995	.000
Error	29933.542	96	97.822		
Total	1149259.000	98			
Corrected Total	36976.269	97			

a. R Squared = .190 (Adjusted R Squared = .188)

Table 7 shows that F (1, 96) = 71.995 and *p* = 0.000. Since *p*< 0.05, the study therefore finds the test statistics to be significant. The null hypothesis which states that there is no significant difference between the mean achievement scores of students who received immediate feedback and those that received delayed feedback when taught chemistry was rejected. This indicates that the difference in mean achievement scores of students who received immediate feedback and those that received delayed feedback when taught chemistry was statistically significant for the delayed feedback but it was not significant on the immediate feedback. Hence, it can be concluded that delayed feedback has more achievement impact on the students.

Hypothesis 4*:* There is no significant difference between the mean achievement scores of male and female students who received delayed feedback and those that receive immediate feedback when taught chemistry.

Table 8: Summary of One-way ANCOVA on the mean achievement scores of male and female students who received delayed feedback and those that receive immediate feedback when taught chemistry

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.486[a]	4	.162	.125	.946	.001
Intercept	1605.584	1	1605.584	1234.247	.000	.802
Male* Delayed Feedback* Immediate Feedback	.401	1	.401	.309	.579	.001
Female* Delayed Feedback* Immediate Feedback	.506	1	.506	.321	.201	.000
Delayed Feedback	.301	1	.351	.333	.432	.005
Immediate Feedback	.009	1	.009	.007	.933	.000
Gender* Delayed Feedback* Immediate Feedback*Achievement	.112	1	.112	.086	.770	.000
Error	395.462	140	1.301			
Total	2412.000	144				
Corrected Total	395.948	143				

a. R Squared = .001 (Adjusted R Squared = -.009)

Table 8 reveals that F (1,140) = 0.086 and $p = 0.770$ for gender, delayed feedback, and immediate feedback. Since $p > 0.05$, the study finds not to be significant. The study therefore, concludes that there was no difference between the mean achievement scores of male and female students who received delayed feedback and those that receive immediate feedback when taught chemistry. The null hypothesis of no significant difference between the mean achievement scores of male and female students who received delayed feedback and those that receive immediate feedback when taught chemistry was not rejected. Hence, gender wasn't a factor

Discussion of the Findings

Findings from the result of data analysis are discussed as follows;

Effect of immediate feedback on students' mean achievement in chemistry

The result of the analysis has shown that immediate feedback of result is effective in enhancing students' achievement in chemistry. The result indicated that students who received immediate feedback of result achieved better in chemistry more than those students with no feedback. The finding of the study revealed that students who received immediate feedback had higher mean achievement scores that those without feedback. This showed that students who received immediate feedback achieved better in chemistry than those students that did not receive any feedback (control group). This finding of the study agrees with the finding of Ajogbeje (2012), and Lemley (2017) who posited that students who are exposed to immediate feedback of result achieve better than those without feedback. This is stemmed from the fact that when students are provided information regarding the correctness or incorrectness of their responses immediately after a formative test, it enhances learning as behaviour is observable and still fresh in memory and thus promote achievement of learned information. Moreover, the relative effectiveness of immediate feedback over no feedback in enhancing students achievement could be attributed to the fact that immediate feedback influences the readiness, interest, motivation and attention of students in the class as well as facilitates the existence of interaction between the teachers and the students, this will make them achieve better than those without feedback as indicated in the higher achievement scores of students who received immediate feedback over students with no feedback.

Effect of delayed feedback on students' mean achievement in chemistry.

The finding of the study revealed that delayed feedback of result improve students achievement in chemistry. The result showed that students who received delayed feedback achieve better than those students with no feedback. The finding of the study showed that students who received delayed feedback had higher mean achievement scores than those without feedback. This showed that students in the experimental group who received delayed feedback achieved better in chemistry than those students who did not receive any feedback (control group). The finding of the study agrees with the finding of Reyes (2013), which showed that students achieved better when they are exposed to delayed feedback of the result than no feedback. This could stem from the fact that when a little time is taken to provide information regarding the correctness or incorrectness of the response to students after a test, it encourages the students to anticipate the answer which may increase their level of attention to it when they eventually receive the feedback, thereby making the students achieve higher as indicated in the higher achievement scores of students who received delayed feedback in chemistry over students with no feedback.

Effect of immediate and delayed feedback on student's mean achievement in chemistry:

The result of the data analysis has shown that feedback, both immediate and delayed feedback of the result are effective in enhancing students achievement and retention in chemistry. This finding agrees with the finding of Sinha(2012) who found out that feedback whether immediate or delayed has a significant effect on students achievement. Further analysis of the result revealed that immediate and delayed feedbacks are more effective in enhancing students' achievement in chemistry than no feedback. Students who receive immediate and delayed feedback of their result had higher academic achievement than their counterparts that didn't receive any feedback.

Furthermore, the finding of the study revealed that students who received delayed feedback had higher mean achievement scores that the students who received immediate feedback. This means that delayed feedback is more effective than immediate feedback in enhancing students' achievement in chemistry. This finding is in agreement with the finding of Ezekwesili and Ngonebu (2015) who found out that delayed feedback is more effective in enhancing student's achievement than immediate feedback. The effectiveness of delayed feedback over immediate feedback could stem from the fact that students tend to correct their wrong responses on their own during the period of delay thereby having a better insight into their errors and this enable them to perform better. In order words, it tends to encourage the students to anticipate the answer which may increase their level of attention to it when they finally receive the feedback. This finding disagrees with the finding of Ajogbeje(2012), which indicated that students who received immediate feedback achieved higher than with delayed feedback. Conclusively, the finding revealed that students who are exposed to delayed feedback of their result achieve and retain better in chemistry.

Influence of gender on students mean achievement in chemistry.

The finding of the study on gender from table 4 showed that male and female students achieve higher on their posttest scores for both treatment groups (immediate and delayed feedback) but the male students achieve higher than their female counterparts. However, the hypothesis testing revealed that this difference in the mean achievement scores for both male and female students exposed to immediate and delayed feedback is not significant. The finding of the study revealed that there is no significant difference in the mean achievement scores of male and female students when they received immediate and delayed feedback in chemistry. In order words, gender has no effect on the mean achievement of students in chemistry when they receive immediate and delayed feedback of the result. This finding is in agreement with the finding of Omeke (2012) which showed that gender has no effect on students' achievement in chemistry. The finding equally collaborated with the finding of Ogbonna (2010), that there is no significant difference in the achievement of male and female students in chemistry. In order words, they maintained that gender has no significant influence on the academic achievement of students in chemistry. Nevertheless, the finding of the study disagrees with the finding of Ameh (2014) and Apper (2016) who found significant difference in the achievement of male and female student in chemistry. They maintained that gender has significant influence on the academic achievement in chemistry. Meanwhile, the effectiveness of both feedbacks (immediate and delayed) on both male and female students could be attributed to the fact that students were given equal opportunity to receive the feedbacks irrespective of their gender. The fact that the difference in achievement of both male and female students in chemistry is not significant means that the feedback employed whether immediate and delayed are equally effective for male as well as female students in enhancing academic achievement. In order words, gender has no significant influence on the academic achievement of students when effective assessment procedure such as immediate and delayed feedback are employed by the teacher during teaching and learning.

Conclusion

From the findings of this study it is concluded that immediate feedback and delayed feedback used in this study had significant effect on students' academic achievement in the topic taught. This means that these assessment procedures were effective in improving students' achievement in chemistry. Meanwhile, the researcher further found out that students that received immediate and delayed feedback of their results were more effective that the students with no feedback in enhancing students' achievement in chemistry. These assessment procedures (immediate and delayed feedback) have been proven to be more effective in facilitating students' achievement in chemistry more that no feedback. Moreover, the study also found that students exposed to delayed feedback of result enhance students' achievement in chemistry more than those exposed to immediate feedback of result. The study also found out that there was no significant difference in the academic achievement of male and female students in chemical equilibrium in chemistry. Based on the findings of this study, it has be established that when teachers give delayed feedback of result as a form of assessment or evaluation procedure after a given test during teaching and learning in chemistry, students' achievement would greatly improved and this improvement will not be significantly influence by gender.

Educational Implications of the Study

The finding of this study has some obvious educational implication for the chemistry teachers, students, chemistry curriculum planners and ministry of Education.

The study has provided an empirical evidence to support the efficacy of giving delayed feedback of students' result of test or tasks in facilitating students' achievement in SSII chemistry. The researcher therefore advocates the need for the chemistry teachers to employ the use of delayed feedback assessment procedure in order to equip them with the knowledge of knowing the strength and weaknesses of the students undergoing instruction and give appropriate remedial teaching for improved academic achievement.. In order words, it will assist the teachers to guide, direct and monitor student learning and progress towards improved performance. The finding of the study further revealed that there was no significant interaction effect of immediate feedback, delayed feedback and gender on students' achievement in chemistry. This means that students whether male or female achieve higher when they are provided with the feedback of their result especially delayed feedback of their results.

The findings of the study also have implication for the chemistry students. When the result of their assessment is made known to them, it will make the students concerned to begin to have a better understanding of their capabilities and develop capacity to monitor, evaluate and regulate their own learning. In order words, the finding of the study will motivate the students and provide information that they can use to improve their learning which leads to improved academic achievement.

The efficiency of employing feedback especially delayed feedback of result as an assessment procedure has been proven as indicated by the findings of the study. It therefore becomes necessary that chemistry curriculum planners should adopt such approach and incorporate the use of feedback assessment procedure during teaching and learning process in schools.

To the Ministry of Education, the findings of the study implies that workshops, seminars and conferences should be organized from time to time for the chemistry seminars and conferences should be organized from time to time for the chemistry teachers in order to train and sensitize them on the need to incorporate feedback especially delayed feedback assessment procedure during teaching and learning.

Recommendations

In view of the afore-mentioned educational implication of the findings of this study, the research hereby recommends as follows:

1. Chemistry teachers should ensure that students are given feedback especially delayed feedback of their result during teaching and learning by providing an explanation and examples as to what is accurate and inaccurate about their work. This will make the students concern to begin to have a better understanding of their capabilities and develop capacity to monitor and evaluate their own learning leading to improve academic achievement in chemistry.
2. Feedback (especially delayed feedback) assessment procedure should be included in the chemistry curriculum of teachers training Institutions, in order to popularize their use among the teacher trainees so as to bring about more effective achievement in chemistry in the secondary schools. This is because, the finding of the study have proven that delayed feedback are more effective in enhancing students achievement in chemistry than immediate feedback and no feedback.
3. Chemistry teachers should be encouraged to attend regular workshops and seminars to acquaint themselves with those requisite skills associated with delayed feedback assessment procedure. Such workshops should be organized by government and professional bodies such as STAN to educate and sensitize them in the effectiveness of using the procedure in enhancing students' achievement.
4. Government agencies/bodies, professional association and curriculum planners should ensure that curriculum implementers put into practice the use of delayed feedback assessment procedure in teaching and learning.

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EFFECT OF INTEGRATED TEACHING METHOD ON SENIOR SECONDARY SCHOOL ACHIEVEMENT AND RETENTION IN CHEMISTRY

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Abstract

The study sought to measure the effect of integrated approach on academic achievement of senior secondary school Chemistry students. Two (2) research questions and 2 research hypotheses guided the study. The study employed quasi–experimental design. The sample comprised 160 SS 72 males and 77 females chemistry students drawn from 1062 population (563 male and 499 female) in 60 public co-educational school in Nsukka education zone of Enugu State Nigeria. The experimental groups were exposed to integrated approach while control group were expose to lecture. Data was collected using electrochemistry achievement test which was validated by three experts and reliability index of 0.707 were obtained using Kuder-Richardson's formula 20. The research questions were answered using mean and standard deviation while the hypotheses were tested at 5% level of significance, using analysis by covariance. The findings revealed that integrated approach was more effective in enhancing students' achievement and retention in chemistry than lecture method. Also, there was no significance different in male and female student's achievement in chemistry. Based on the findings the research recommends, among others, that chemistry teachers should teach chemistry with integrated approach to encourage active engagement, self-motivation and retention among learners to enhanced academic achievement.

Keywords: Integral Instructional Approach, Achievement, Retention and Gender.

Introduction

The fast growing accessibility and capability of today's educational development complied with the global scientific scenario have given rise to the need for designing and implementing innovative teaching methods for effective teaching and learning of science subjects. At the moment, the West African Examination Council's Chief Examiners' yearly reports (2015-2020) have shown inconsistence achievement in science subject especially chemistry. The poor and inconsistence achievement has been attributed to many factors, one of which is the use of in appropriate teaching methods like conventional lecture method, stressing further the authors explained that this method is usually the theoretical and it may hinder meaningful learning thereby lending to poor achievement (Mbajiorgu 2022, Udu 2018, Liu 2015, Nweze & Uzochukwu, 2019). Predominate on these note, Nwagbo and Ngwanyi (2017), and Ndubuizu (2016) asserted that science teaching especially chemistry showed entails theory as well as practical to enable the learners to have the understanding of basic concepts acquire laboratory skills, be aware of the interrelationship between chemistry and other disciplines and be aware of the link age between chemistry and in study/environment/everyday life in terms of benefits and hazards, and skill of critical and logical thinking as stipulated in chemistry curriculum (2016). Ndubuizu (2016) further explained that the teaching of chemistry has been reduced to descriptive exercised through the use of lecture method and that teaching of chemistry should be practical – based activity while Gabriel, Osuafor, Cornelius, Obinna and Francis (2018) were of the view that the use of lecture method in teaching chemistry without combining it with other methods might not be suitable for effective learning by the students and positive retain ability. The search for teaching methods capable of ensuring students understanding and appreciation of science concepts is largely imminence by the fact that conventional (lecture) teaching method has failed to enable student achieve the objectives of chemistry, hence Smith, A., & Johnson, B. (2020). opined that lecture method is descriptive and the teacher does all talking, rarely does he/she uses another resources thus, there is little or room for enhance of ideas, so it said to be teacher centred while Miller (2017) noted that in teacher-centered environment learners usually have phobia and find it difficult to understand the subject matter which lead to poor retention and poor achievement but approaches such as integrated approach like demonstration and practical laboratory work because theoretical teaching without practical at the same time is then major reason why student have phobia and perceive chemistry as being difficult.

Udu (2018) observed that lecture method us theoretical teaching is like a valley of dry bones, but as soon the theory is exemplified with practical, the dry bones put on flesh and blood and come to life hence, a call for renewed teachers effort at using integrated approach in Secondary School chemistry teaching to enhance retention and achievement. Integrated instructional approach is bring different teaching method/different style of teaching to teach a particular concept at a time. Integrated approach could be defined as the method of teaching where various styles are used at a time with relevant and related practical laboratory work for effective understanding of science concept that's bring different teaching method in order to deliver a lesson at a particular time in order to enhance learning. Integrated instructional approach of demonstration and laboratory practical work is a student-centered because its activity oriented teaching strategy where the teachers act as a facilitator of learning after demonstrating for the students' and then watch and the students carry out the experiment while he/she guide their activities.

The basis of integrating demonstration and laboratory practical work while teaching chemistry is to make it a fun equally practical experience constituent integral part of chemistry because the subject consists of many topics that can be verified experimentally with an objective to create and enabling environment to stimulate student learning about chemistry that is commonly presumed as abstract, quantitative and boring when practical work is not properly integrated in teaching of chemistry, it will surely show in their academic achievement due to poor retention. Moreso, the choice of integrating demonstration and practical method is informed by their high engagement of the student in hand on learning which boosts interest, retention and achievement in the teaching activities, thus integration instructional approach is the act of combining two teaching method to teach simultaneously.

It is evident that conventional method (lecture) or demonstration method can be useful in teaching but they all fall into traditional method in teaching science, for demonstrating, the teacher can focus the pupils attention on the relevant facts and introduce scientific principles and concepts but learners are not allowed to ask questions or start discussions, during the demonstration there by the training skills on path of the student is lacking. Based on this, Shehzard and Aziz (2019) was of the view that the use of traditional method (lecture and demonstration) in teaching chemistry without combining it with other method might not be suitable for effective learning by the students. The argument being that telling or snoring is not learning because both makes learners passive recipient of information, adding that there is no learner-teacher interaction during lecture hence, it is teacher-centered.

The concept of teacher-centered is often associated with low participation in class room by student, lack discussion, exchange of ideals, lack questioning etc. between the teacher and students or among the students in a classroom. However, Dave-ugwu, Ogugu and Dike (2019) noted that needed for proper understanding of chemistry principles concepts and facts, there should be participation between the teacher and the students' thus, environment and poorly managed participation of students in any teaching environment involves unidirectional flow of information/knowledge from teacher to the student and do not encourage process skills acquisition in classroom activities which can lead to instruction frustration, phobia, confusion and tagging a particular subject very difficult. On this note Umar (2019), Ezedimma (2016), Olorundare (2014) and Orji (2015) anticipated from a shift of emphasis from the teacher-centred (traditional method) less effective predominantly students understanding and appreciation of science concept in order to increase retention and achievement.

Retention means the act of keeping and recalling something rather than losing Eramus (2019) viewed retention as the repeat performance by a leaner of the behaviours that an acquired piece knowledge is always intended to elicit in the learner (with practice) after an interval of time Whie Bamiro (2015) saw retention as the ability to retain and later recall information or knowledge gained after learning. The author stated that anything that aid learning should improve retention while things that lead to confusion, or interference among learning materials decrease the speed and efficiency of learning and accelerates forgetting that leads to poor achievement

Achievement according to Adzape (2015) is something done successfully, typically by effort, courage or still, an act that has been performed successfully while Ezedimma (2016) opined that academic achievement is the represents learning outcomes that indicates the extent to which a person has accomplished special goals that were the focus activities in instructional environments.

However, there are several factors responsible for students' poor performance in chemistry but many researchers hinged it to lack of teaching method which leads to poor retention and poor achievement in considering the efficiency of integrated approach of teaching, gender was considered as a variable because influences of gender on students' retention and achievement has for a long time been of concern to many researchers but no consistent result has been established Njoku and Attah (2019) Okotcha (2018) asserts that male students retain and achieve better than their female counterparts in science subject while Nnamani and Oyibo (2016), Nzekwe (2018) and Ezeano (2013) found that female students achieved significantly higher than their male counterparts while other researchers are of the view that there's no significant differences between them. It can deduced from the foregoing that the issue of gender in chemistry retention and achievement has no yet been resolved. Hence the need for this present study is justified.

Purpose of the Study

The purpose of this study was to determine the effectiveness of integrated approach in enhancing students' academic achievement and retention in electro-chemistry. Specifically, the study sought to:

1. Determine the mean achievement scores of SS II chemistry students taught electrochemistry with integrated approach and those taught using conventional (lecture) method.
2. Determine the mean retention scores of SS II students taught electrochemistry with integrated approach and those taught with conventional method (lecture).

Research Questions

In order to achieve the purpose of this research work, the study sought answers to the following research questions:

1. What are the mean achievement scores of SS II chemistry students taught electrochemistry with integrated approach and those taught using conventional (lecture) method?
2. What are the mean retention scores of SS II students taught electrochemistry with integrated approach and those taught with conventional method (lecture)?

Hypotheses

The following null hypotheses tested at 5% level of significance guided the study.

Ho$_1$: There is no significant difference between mean achievement scores of SS II chemistry students taught electrochemistry with integrated approach and those taught using conventional (lecture) method.

Ho$_2$: There is no significant difference in mean retention scores of SS II students taught electrochemistry with integrated approach and those taught with conventional method (lecture)

Method

The research adopted the pre-test, post-test, non-equivalent, control group, quasi-experimental design. The population of the study comprised 1062 (563 male and 499) of all he SS II student in Nsukka Education zone of Enugu State. A sample size of 160 (77 males and 83 females) of SS II chemistry students was used for the study. The sample was obtained using multistage procedures. The instrument used for data collection was electrochemistry achievement test (EAT) developed by the researcher. Test blue print or table of specification was used in preparing the test which was based on the six levels of cognitive domain of Bloom's taxonomy of education to ensure proper cover. The test contain fifty questions with four options ranging from A-D for students to select their best answers. The instrument developed was validated by three experts drawn from department of science education (measurement and evaluation, and chemistry units) and table of specification was used to ascertain the content validity of the instrument was established by administering 30 copies of the instrument to 30 SS II chemistry students in Obollo Education zone of Enugu State who are not part of the study but share the same characteristics with the students under investigation. The reliability index of 0. 707 was obtained using Kuder-Richardson's formula 20 (K-R-20) formula. The instrument for collection of data (EAT) was administered to chemistry students in sample schools before the commencement of the experiment which serve as pretest score. After the pretest, the actual experiment commenced, which started with the training of chemistry teachers who were used for the study. The subjects were randomly assigned to two groups. One group were taught with integrated approach and another group with conventional lecture method. After which EAT was administered a gain for post test and re-shuffled to serve for post-posttest or post-retest to measure retention and the scored obtained deviation used in answering all the questions while analysis of covariance (ANCOVA) was used in testing the formulated hypotheses at 0.05 level of significance.

Results

The results of the study are organized based on the research questions and hypotheses that were formulated for the study.

Research Question 1

What are the mean achievement scores of SS II chemistry students taught electrochemistry with integrated approach and those taught using conventional (lecture) method

Table 1:
Mean achievement scores of experimental and control groups

Treatment	**N**	**Pretest**	***SD***	**Posttest**	***SD***	***Mean Gain/Loss***
Experimental Group	81	15.53	5.34	35.91	7.52	20.38
Control Group	79	15.62	3.91	20.43	5.17	4.81

Table 1 shows that the students in experimental (   ) and control group (   ) had almost the same pretest mean scores. Their standard deviation scores show that their scores are close to each and not widely spread. This thus, means that the students in both groups were in the same academic baseline before the instructional treatment (integrated approach). However, after the treatment, the group taught chemistry using integrated approach achieved (   ) higher than their counterpart in the control group (   ) evident in their posttest scores and mean gains.

Hypothesis 1
There is no significant difference in the mean achievement and standard deviation scores of SS II students taught electrochemistry using integrated approach and those taught using conventional lecture method

Table 2:
Analysis of covariance (ANCOVA) of students' mean achievement scores by treatment and gender

Tests of Between-Subjects Effects

Dependent Variable: posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9789.888[a]	4	2447.472	59.242	.000	.605
Intercept	7850.298	1	7850.298	190.019	.000	.551
Pretest	191.573	1	191.573	4.637	.033	.029
Method	9203.322	1	9203.322	222.769	.000	.590
Gender	.015	1	.015	.000	.985	.000
method * gender	4.336	1	4.336	.105	.746	.001
Error	6403.556	155	41.313			
Total	144053.000	160				
Corrected Total	16193.444	159				

a. R Squared = .605 (Adjusted R Squared = .594)

From Table 2, F($_{1,}$ 155)=222.769, P=0.000<0.05 showing that the associate probability (sig.) is less than the probability value of 0.05. Thus, the null hypothesis is not accepted, but the alternative upheld. The Table also reveals an effect size (partial Eta square) of 0.5900 indicating that the treatment contributed 59% to students' achievement in chemistry indicating high effect of treatment on the achievement. Thus, there is a significant difference in the mean achievement

and standard deviation scores of SS II students taught electrochemistry using integrated approach and those taught using conventional lecture method in favour of students taught using integrated approach.

Research Question 2

What are the mean retention scores of SS II students taught electrochemistry with integrated approach and those taught with conventional method (lecture)?

Table 3:

Mean and standard deviation retention scores of experimental and control groups

Treatment	**N**	**Posttest**	***SD***	**Retention**	***SD***	***Mean Gain/Loss***
Experimental Group		35.91	7.52	36.12	7.18	0.21
Control Group		20.43	5.19	19.84	6.64	-0.59

Table 3 shows the mean achievement and standard deviation scores of the experimental group ( ) and control group ( ). Also, the mean and standard deviation retention scores of experimental group ( ) with mean gain of 0.21 and control group (with mean loss of 0.59 were shown. This means that integrated approach helped the students to retain the chemistry content taught.

Hypothesis 2

There is no significant difference in the mean retention scores of SS II students taught electrochemistry using integrated approach and those taught using conventional lecture method

Table 4:
ANCOVA analysis of mean scores of students' retention by treatment and gender
Tests of Between-Subjects Effects
Dependent Variable: retention

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12598.790[a]	4	3149.697	87.505	.000	.693
Intercept	1287.250	1	1287.250	35.762	.000	.187
Posttest	1948.852	1	1948.852	54.143	.000	.259
Method	1052.686	1	1052.686	29.246	.000	.159
Gender	36.827	1	36.827	1.023	.313	.007
method * gender	20.843	1	20.843	.579	.448	.004
Error	5579.154	155	35.995			
Total	144347.000	160				
Corrected Total	18177.944	159				

a. R Squared = .693 (Adjusted R Squared = .685)

From Table 4, F($_{1,\ 155}$)=29.246, P=0.000<0.05 showing that the associate probability (sig.) is less than the probability value of 0.05. Thus, the null hypothesis is not accepted, but the alternative is upheld. The Table also reveals an effect size (partial Eta square) of 0.159 indicating that the treatment contributed 15.9% to students' retention in electrochemistry. Thus, there is a significant difference in the mean retention and standard deviation scores of SS II students taught electrochemistry using integrated approach and those taught using conventional lecture method in favour of students in treatment group.

Discussion of the Findings

Findings also reveal that students taught electrochemistry using integrated approach retained electrochemical content more than their counterpart taught using lecture method. Thus, there is a significant effect of integrated approach on students' retention in electrochemistry. Also, Chemistry teaching requires the use of integrated approaches since without proper experiment/demonstration to show the 'how' of the concept being taught, its learning will be hampered. Thus, when students are taught using integrated approach, the students will not just achieve well but the information learnt will be retained. Findings of Eze (2013) who found that discussion method improves students' achievement than lecture method also agreed with the findings of the present study. Also, findings of Ezema (2013) who investigate the effect of practical activities and found that experimentation method promotes students achievement equally agreed with the findings of the present study.

Similarly, the study of Ezeudu (2013) investigated the effects of Lecture Method Supplemented with Music (LMM) and Computer Animation (LMC) on senior secondary school students' retention in electrochemistry. Ezeudu emphasis that in any learning environment that the teacher should place retention at centre because ability to achieve depends mainly on ability to recall.

Conclusion

On the basis of this study, the following conclusions have been made;

1. The use of integrated approach enhances academic achievement in chemistry when compared with conventional lecture method
2. Integrated approach proved superior to conventional method in promoting students retention in electrochemistry
3. Integrated approach were gender friendly

Educational Implications of the Findings

The implication of the findings to teachers is that it is better to use different teaching methods in the course of teaching than just use one which could be monotonous and so may not improve achievement and retention. Moreso, at the stage of chosen methods to adopt in a given teaching, methods that are gender friendly like integrated approaches should be given priority.

This basically will promote their achievement and retention. For curriculum planners, the findings have implications to them by pointing at the effectiveness of integrated approach on students' achievement and retention. So they should take note of this and do the needful. The findings of this study to government is that findings from studies should be collated by her different school agencies and ensure that they are implemented in the schools. For future researchers, the findings of the studies have given them direction to following for similar investigation in the future and thus should check the effectiveness of other integrated methods on students' achievement and retention.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. integrated approaches should be adopted by chemistry and indeed other science teachers because it promotes students' achievement and retention
2. practical apparati should be made available in our schools by the government to enable teachers use them in teaching the students using integrated approaches
3. based on the gender friendly nature of the instructional approach, it should be used in teaching mixed and single sex students
4. school authorities should ensure that no teacher, teaches chemistry and other sciences without exploring laboratory and demonstration methods

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ATTITUDE AS PREDICTOR OF ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL PHYSICS STUDENTS' IN AGBANI EDUCATION ZONE

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Abstract

Students' continuous underachievement in physics has underpinned the efficacy of non-cognitive variables like students attitude in physics. Therefore, the purpose of the study was to investigate attitude as predictor of academic achievement of secondary school Physics students in Agbani Education Zone of Enugu State. An Ex-post-facto and correlational survey research design was adopted for the study. The population of the study was 2752 SS II Physics students' in Agbani education zone from 44 public schools. Purposive sampling procedure was used in selecting 275 Physics students comprising 144 males and 131 females from twelve selected schools in the Zone. Physics Attitude Scale (PAS) adapted from Sumeyye and Oktay (2020) and Students' Achievement Scores obtained from their promotion examination results of 2022/2023 academic session from the schools used were used for data collection. The instrument (PAS) was face validated by three experts and tested for reliability using Cronbach's alpha with the reliability index of 0.82. Data were analyzed using simple regressions. The results indicated that attitude relatively and significantly contributed 39% to the prediction of academic achievement of secondary school Physics. Based on these findings, it was recommended that students should develop positive attitude in physics. Teachers should adopt teaching strategies that would stimulate students' positive attitude in teaching Physics.

***KeyWords**:* Physics, Attitude, Gender and Academic achievement

Introduction

Physics is vital to a nation's technical advancement because it gives its people the means to do their daily tasks with efficiency. Physics is vital in many sectors, including technology, engineering, medicine, biotechnology, nursing, and agriculture. Consequently, in its national education policy, the Federal Republic of Nigeria (FRN, 2014) declared physics to be a basic subject that should be taught as integrated science from junior secondary school through senior secondary school and postsecondary institutions. The scientific study of matter, objects, and energy in a particular system or environment is known as physics (Onah, 2022). Every branch of science stems from physics, which is the most fundamental (Eryilmaz, 2016). According to Anyakoha (2016), physics is a natural science that involves the study of matter and energy and their interactions. Physics is the study of natural phenomenon at its most fundamental levels and manner (Onah, 2022). Physics deals with the study of laws that determine the structure of the universe with reference to the matter and energy in the universe (Ike, 2014). Physics as the core subject taught in secondary school contributes to the cognitive development of the students. Physics is the most utilized basic science subjects in most technology and technology-based profession. This is because, physics, exposes the students to the true nature of the universe around them; and as well forms the basis for the nation's technological advancement and human resource development (Abubakar, 2012). Physics knowledge has contributed immensely to the production of tools and devices of tremendous advantage to the human race (Sani, 2012). This merely indicates that the enormous role Physics plays in the technological growth of any nation must not be undermined. Physics is the most basic of science and its concepts and techniques underlines the understanding of all other branches of science. The knowledge of physics facilitates our understanding of other disciplines; thorough understanding of quantum mechanics is necessary to chemists and material scientists since the structure of every atom in the universe is determined by quantum mechanics. Physics is also a cross-cutting discipline that has applications in many sectors for economic development, including health, agriculture, water, and energy and information technology. The knowledge of physics according to Gabriel (2012) offers the learners the opportunity to think critically, reason analytically and acquire the spirit of enquiry. The researcher also maintained that the knowledge of physics develops in students, the scientific and technological knowledge, skills and attitudes which will assist them to make decisions based on the observation and experimentation. Particularly, in our world developing with technological changes, the place of physics and its applications is quite important. The discovery in Physics led to the discoveries of valuable devices like computers, lasers, transistor etc. these devices has been found paramount to the development of technological science (Onah & Achufusi, 2022). Notwithstanding, the numerous benefits of physics especially in the development of science and technology; students find physics concepts boring and difficult owing to the composition of mathematical processes. These students especially those in the secondary schools, argue that physics is abstract.

Interestingly, as important as physics is, students' academic achievement and attitude in the subject at secondary school and institution of higher learning has not been encouraging. In Nigeria, there has been a recurring unacceptable attainment of students in physics. Record of students' performance at Senior School Certificate Examination (SSCE) in physics conducted by West African Examination Council (WAEC) according to Adolphous (2018) shows that between 2001 and 2009 (except in 2006), less than 50% of the students who enrolled for physics obtained credit level pass and above to secure admission into the university in order to pursue courses that require physics. The researcher also stressed that the failure rate continued from 2007 to 2009 (42.9%, 47.1% and 46.2%) and in 2013 (46%) with an improved achievement in 2010, 2011 and 2012 (50.2%, 62.6% and 67.2%). According to Onah and Achufusi (2022) the failure trends continued in 2015, 2017; and 2020 (47.83%, 41% & 36% respectively) with an improved achievement in 2016, 2018; and 2019 (71%, 87% & 80% respectively). In general, this cannot be considered an acceptable achievement as many have lamented that achievement of Nigeria students in physics at the Senior School Certificate Examination (SSCE) has been generally not so good (Adaramola & Obomanu, 2011). Even the WEAC chief examiners (2019), report that this poor achievement of the students' could be linked to their poor attitude in the subject. They suggested as well that teachers should teach students with students' centred approach to enhance their attitude in physics. They also suggested that teachers should attend coordination during WAEC marking to decipher viable methods to enhance students' attitude. According to Okigbo and Okeke, (2011) who observed that students' poor attitude has been traced to their anxiety and fear in the subject which was evident in their poor achievement.

The students' poor achievement in physics in particular and sciences in general has been attributed to many factors. These include; poor methods of physics instruction by the teachers, insufficient number of qualified physics teachers, lack of indigenous textbooks, inadequate apparatus in the physics laboratory, poor classroom management by physics teachers, teacher's belief and attitude towards physics, physics teacher's inability to improvise, inadequate instructional materials and aids, educational background and parental expectations on the learners and finally students' related factors or variables like students' academic anxiety, academic self-efficacy, academic locus of control, academic motivation and more (Adedayo & Jegede, 2013 pg 80-83). This study therefore, is set to find out the predictive power of students' attitude on their academic achievement in Physics.

Attitude is a psychological construct or feelings inferred for a given observable. Attitude is referred to as entry characteristics of the students towards a given concept or subject. Attitude is related to thinking, feeling, perceiving, liking and behaving toward a cognitive observable. Attitude is a tendency to react favorably or unfavorably towards a designated subject matter. According to Olasehinde and Olatoye (2014), attitude is the tendency of liking or reacting favorably or unfavorably towards an event of observation. An academic attitude involves learning to trust your own critical abilities and being assessed on your own achievement and performance. A student's attitude is their tendency to respond in a certain way towards something. Naturally, the student's response can be on a continuum of positive to negative or good to bad. When a teacher says that a student has a bad attitude, they mean that the student did not respond positively to something they were asked to do. The opposite is also true; a student with a good attitude is likely someone who has a cooperative spirit in terms of complying with what they are asked to do by the teacher. Attitude does not only include the negative attitude such a prejudices biases and dislikes, but also positive attitudes are sometimes called sentiment, which include our attachment and loyalties to person, objects and ideas. Attitude thus seems like a system of ideas with an emotional content. An individual possesses his or her life, he or she acquires not only skills and knowledge, but also definite attitudes, point of views and feelings about his or her experiences. These definite attitudes, point of views and feelings are developed not only due to what kind of experiences the individual passes through, but also how these experiences came across. A person with positive attitude towards a concept will consciously or unconsciously thinks, demonstrate traits of innate liking for the concept (Olatoye & Aderogba, 2012). The contemporary theorists (Osgood & Tannenbaum, 1957), on attitude carved out three components of attitude as personal or dispositional attitude, situational attitude; and social information attitude. The dispositional attitude is viewed as an attitude that is almost the same as a personality trait. Students are born to have a positive or negative outlook in different situations. In other words, if they are happy, they are happy, and if they are sad, they are sad. From a teaching perspective, it is a random chance whether a student will enjoy the teacher's class or not. This is not overly optimistic in terms of changing a student's viewpoint, while situational attitude is the kind of attitude that emerges depending on the context of the situational affiliation of the subject. For example, if students struggle to understand physics by virtue of its mathematical concepts, they may develop a negative attitude about physics through mathematics all together. However, the opposite is also true in that success will cause the development of a positive attitude. Or by the use of ineffective teaching material, may as well make the students feel bored about the subject. This view allows a teacher to try to find situations in which students can have success and good attitude so that they can inculcate a positive attitude. Lastly, the social information processing attitude views attitude as those attributions that emanate from friends and associates interference. It is also viewed as attitudes caught from the people around us. For example, if a student with a neutral (naive) attitude is surrounded by students with negative attitudes, they also will develop a negative attitude, the opposite is also true. As well, a student may hate a subject simply because his friend does not like the said subject. Students pick up on the information about various topics from the environment, which can largely shape their attitude towards something. Attitudes determine how an individual thinks, feels or reacts towards an object. If students have better attitude towards an object or subject, it is easier to lead them towards desirable objectives. According to an observation by Bansal (2017), bad instructional strategies that do not promote meaningful learning and tend to make students develop negative feeling and behavior towards learning materials has negative toil on their achievement. This is because as negative attitude is known to affect students' involvement in learning and achievement (John, 2014). As innovative instruction provides concrete examples and engages students in learning process, it is expected to have positive influence on students' attitude. Onah and Anamezie (2022), opines that if teachers show weaknesses in their knowledge of the subject, this might create a lack of confidence in students about the teachers' abilities and knowledge. The effect of this among others is that a student may become less attentive and develop negative attitude towards both physics as a subject, and the teacher. Attitude in Physics is viewed/ considered under the following factors:

- Motivation factor: this represents how much of an effort the student puts in while learning physics. This usually comes from situational construct of classroom instructions. It includes reinforcement, use of suitable teaching pedagogy and conducive learning atmosphere.

- Anxiety about physics factor: this represents how the student feels/ fears when learning physics. It can be linked to teacher's inability to demystify difficult contents of physics.
- Interest in physics courses factor: this represents what the student likes/ thinks about physics courses. It requires the ability of the students to have innate liking for physics subject.
- Self-sufficiency factor: this represents the student's confidence in his/her skills in physics.
- Anxiety about mathematics factor: this expresses how the student feels when he/she has to use mathematical expressions during physics courses.

These potentials of attitude incites the need for further investigation into the predictive power of attitude and whether they could improve the achievement of male and female students in physics irrespective of gender.

Gender has been noted by researchers over the years as having an impact on achievement in Physics and its related disciplines. Akumah, (2013) stressed that science, technology, and their related disciplines are male-reserved while Art and Humanities are female reserved. This belief makes boys appear to have a naturally positive attitude towards science and technical subjects while girls show more inclination to Arts and Humanities. The problem is even compounded by the fact that most science educators give masculine outlook to science subjects such as chemistry and physics, this discrepancy was evident in the students' achievement in Chemistry (Ezeano, 2013); encouraging females to go rather for biology, agricultural science and home economics which they consider to be more female-friendly science subjects. Some other researchers (Onah & Achufusi, 2022, Nwankwo & Okoye, 2015; Orefor, 2016) opined that gender has no influence on students' achievement in the sciences. All these and related treatments make girls have phobia for science and science-related subjects which definitely affect their future career-choice and eventual achievement. Due to lack of consensus regarding the issue of gender and science and more importantly to capture the interest of girls, and consequently improve their achievement in physics and other science-related carriers, there is a need therefore, to investigate the predictive power of attitude on achievement of male and female students in the sciences especially Physics.

Statement of the Problem

The problem of poor attitude in science subjects especially Physics is no longer news in the teaching and learning of physics. Researchers and physics teachers have ever since been seeking ways to bring the attitude of students to an appreciable extent. This stands to be a great challenge facing the education system in Nigeria. Although many other challenges such as quality of science teachers, lack of science equipment, poor incentives among others have over time been queried, further investigations still have to be carried out especially using students since they are the primary factors here.

These factors have over time resulted to gross poor attitude in physics which often lead to low enrollment in the subject especially the females. This situation is causing a lot of concern to science educators. There is considerable evidence in literature to show that traditional physics instruction, predominantly based on lectures and manipulation of formulae to teach a concept is ineffective. It is against this backdrop and quest for better ways of providing effective teaching and learning of physics concepts that the researcher is motivated to embark on the present study. The problem of the study therefore, is "what is the predictive power of attitude on academic achievement of secondary school physics students' in Agbani Education Zone?

Based on the problem of the study, the study investigated the magnitude of prediction of physics students' achievement by their attitude among secondary school Physics students in Enugu Education Zone of Enugu State.

Specifically, the study sought to find the:

1. Prediction of students' academic achievement by their academic attitude in physics.
2. Moderating influence of gender on students' academic attitude prediction of academic achievement of physics students.

The following research questions were designed to guide the study in line with the purpose

1. What is the prediction of students' academic achievement by their academic attitude in Physics?
2. What is the moderating influence of gender on students' academic attitude prediction of academic achievement of physics students?

The following null hypotheses were formulated for the study; which was tested at 0.05 level of significance

1. There is no significant prediction of academic achievement by academic attitude of secondary school Physics students.
2. Moderating influence of gender on students' academic attitude in predicting their academic achievement in physics is not significant.

Method

The study employed an ex-post-facto research design incorporating both the correlation and qualitative approaches to interpret the results of the test of null hypothesis. The ex-post facto research design was chosen because the condition of the (independent variables) learners and the results had already occurred as is expected in such designs that do not manipulate any independent variable (Orodho, 2012). The correlational strand enabled the researcher to determine the relationship between variables through the use of correlational statistics (Wenslaus, 2015). Orodho (2012) notes that in a correlational research, relationships among two or more variables are studied without any attempt to influence them. Orodho (2012) and Brooks (2013) contend that a major purpose of ex-post-facto research design of a correlation subtype is to clarify an understanding of important variables that have already occurred through the identification of relationships among the variables. The study was carried out in Agbani Education Zone, located East of Enugu State, Nigeria. Enugu State has six Education zones which include: Enugu, Awgu, Agbani, Nsukka, Obollo-Afor and Udi. Agbani Education zone consists of three local government areas; namely: Enugu South, Nkanu East and Nkanu West local government area. The area has the first indigenous tertiary institution of the state which is Enugu State University of Science and Technology, Agbani (ESUT). The area is predominantly semi-urban in nature with basic amenities such as good road, hospitals, electricity, schools and markets. Most people living in the zone were civil servants, students, traders and many farmers. The researcher chose Agbani Education Zone due to the fact that most of the secondary schools have qualified physics teachers, laboratories and instructional materials and yet students experience difficulties in answering questions in physics in their external examinations which was evident in their final achievement scores and grades in WAEC results hence the need for the study in the area. Therefore, this research will help the teachers to integrate academic attitude which will in turn enhance good academic achievement. The population for the study was 2,752 SS2 Physics students from 44 public secondary schools in the zone. Two hundred and seventy-five (275) SS2 physics students (144 males & 131 females) drawn through multi-stage sampling approach from twelve co-educational secondary schools in Enugu South and Nkanu West Local Government Area of Enugu State were used for the study.

In stage one, simple random sampling technique (precisely by balloting) was used to select Enugu South and Nkanu West Local Government Areas. In second stage, purposive sampling was used to select twelve co-educational schools in the two local government areas based on the existence in those schools of well-equipped physics laboratories and experienced physics teachers with teaching qualification. Simple random sampling technique (precisely balloting) was next used to select 275 students.

The instruments used for data collection was the Physics Attitude Scale (PAS) adapted from Sumeyye and Oktay (2020). PAS comprises 20 items adapted from a 21-item Physics Attitude Scale developed by Sumeyye and Oktay (2020). Originally, the scales are for students' general attitude scale for physics students but were modified because one item repeated itself. It is a four point scale, ranging from 1 = strongly disagree to 4 = strongly agree, which was used for all items in this instrument. 5 question items had negative cue in the instrument, precisely 5, 6, 7, 20; and 21. These negatively cued items were reverse-scored before the scores were computed at the analysis stage.

The instrument (PAS) was face validated by three experts and tested for reliability using Cronbach alpha which yielded a coefficient of 0.82. Physics academic Achievement scores were extracted from the students' promotional examination of

2020/2021 academic session. The variable of academic achievement is an interval scale. A student's achievement score is lower or higher than another. The research questions and hypotheses were answered/ tested using multiple linear regression analysis. If the p-value is less than 0.05, then the null hypothesis will be rejected and accept alternative hypothesis but if it is greater than 0.05, the null hypothesis will not be rejected.

Results

Research Question 1: What is the prediction of students' academic achievement by their academic attitude in Physics?
Answer to Research question 1 is presented in Table 1

Table 1: Moderated multiple regression analysis on Academic Achievement
Model Summary

Model	R	R Square	Adjusted R Square
1	.624[a]	.389	.385
2	.628[b]	.394	.388

Table 1 shows that the independent variable (attitude) as seen in model 1, has significant influence on the academic achievement of the students with the value of R^2 = .389 and adjusted R^2 = .385, it implies that the independent variable; attitude contributed approximately 39% prediction of academic achievement of Physics students.

Research Question 2: What is the moderating influence of gender on students' academic attitude prediction of academic achievement of physics students?
Answer to Research question 2 is presented in Table 1

Table 1 shows that the independent variable (attitude) as seen in model 2 of the model summary table showed addition of the moderator variable (gender) to the predictor variable made significant contribution to the prediction of students' academic achievement (R^2 = .394) and adjusted R^2 =.388, it implies that academic attitude contributed approximately 39% when moderating gender.

Hypothesis 1: There is no significant prediction of academic achievement by academic attitude of secondary school Physics students in Agbani Education Zone.

Table 2: Relative Contribution of Physics Academic Attitude to the prediction of their academic achievement in Physics

Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	14.555	3.923		3.710	.000	6.831	22.278
Gender	.070	.793	.004	.088	.930	-1.491	1.631
Attitude	.784	.060	.624	13.159	.000	.667	.901
2 (Constant)	31.178	11.417		2.731	.007	8.700	53.656
Gender	-11.416	7.453	-.683	-1.532	.127	-26.090	3.257
Attitude	.516	.183	.411	2.823	.005	.156	.876
Gender*Attitude	.185	.120	.718	1.550	.122	-.050	.421

Table 2 shows the unstandardized coefficients with t- and p-values of the predictor and the moderator variables respectively. The table showed that the independent variable made a significant contribution to the prediction of physics academic achievement. Considering the extent of contribution, attitude, the un-standardized coefficient (B = .784) and standardized coefficient or slope (= .624) was significantly different from 0.000 (t = 13.159; $P < 0.05$). This indicates that for every one point increase in students' academic attitude, their academic achievement increased by 78/100 when controlling gender. Therefore, null hypothesis was thus rejected. There was statistical significant contribution of students' attitude to the prediction of their academic achievement in Physics.

Table 3: Analysis of Variance on the Moderated Multiple Regression

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7465.325	2	3732.663	86.613	$.000^b$
	Residual	11722.115	272	43.096		
	Total	19187.440	274			
2	Regression	7568.308	3	2522.769	58.840	$.000^c$
	Residual	11619.132	271	42.875		
	Total	19187.440	274			

Table 3 showed the output of **ANOVA** on the moderated multiple regression. It shows in model 1, F (2, 272) = 86.613; $P < 0.05$. This added weight for the rejection of the null hypothesis. Hence, the independent variable (attitude) significantly predicted academic achievement of Physics students.

Hypothesis 2: Moderating influence of gender on students' academic attitude in predicting their academic achievement in physics is not significant.

Table 2 shows the moderating effect of gender on attitude, the un-standardized coefficient (B = 0.070) and standardized coefficient (= .004) was not statistically significant different from 0.00 (t = 0.088; P > 0.05), thus the null hypothesis was not rejected. Therefore, moderating influence of gender on students' academic attitude in predicting their academic achievement in physics is insignificant. More so, the interaction effect of gender and attitude shows insignificant with the un-standardized coefficient (B = .185) and standardized coefficient or slope (= .718) was not significantly different from 0.000 (t = 1.550; P > 0.05). Therefore, there is no significant interaction of gender on attitude in predicting physics students' academic achievement.

Discussion

The finding of the study showed that there is a significant prediction power between the attitude of the students and their achievement in physics. This implied that students who possess good attitude in their learning of physics will have better achievement. When the students are properly developed in their attitude in physics it will give them a good motivations, self-sufficient, interest in physics and liking that will enable them function effectively in physics knowledge and classroom experiences. Therefore, the level of attitude development that the students have will affect their achievement in physics. This find is in line with the Ojo (2019), Olasehinde and Olatoye (2014) and Luzale (2012), Okafor, (2020), Awodun *et al* (2013), Kpolovie et al (2014), Femi-Adeoye and Adekunle (2016) and Ezike (2018) who found out that attitude of the students enables them to remember concept taught in physics by reading the context regularly and consequently aided their improved academic achievement.

The gender has no implication on the attitude of the students and their achievement in physics. The study showed insignificant difference in the prediction of academic achievement with gender interaction. The study was in line with the findings of Padmini (2017), Godpower-Echie and Ihenko (2017), Okafor, (2020) who also observed no gender difference in the relationship with attitude with students' learning outcomes. The study also disagreed with Ezike(2018), Awodun et al (2013) who observed significant different with gender in the relationship between gender and their academic achievement in physics. It is obvious that there is no agreement in the research community concerning the interaction effect of gender and cognitive learning skills and attitude in Physics on students' conceptual understanding of science especially physics concepts and achievement. The differences in observation by different researchers could be attributed to the influence of location and some other extraneous threats to the experiment. There is therefore a great need to embark in more studies in order to shed further light on this issue.

Conclusion/Recommendations

Based on the findings, the study concludes that development and use of attitude will go a long way in improving academic achievement in physics among secondary school students with regardless of gender. It was recommended that teachers should challenge the students with learning materials that will encourage them to develop good attitude. Schools authorities should engage the services of guidance and counselors that will help students to know how to improve their attitude and apply them to achieve their learning needs. More so, Physics teachers should arrange learning activities in such a way that it will help students to be self-directed, self-sufficient in their learning which will help them apply all the attitude both personal, situational and socio information attitude in the learning of physics.

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